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A Review of Container Glass Compositions (1932—1957)

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• ANALYTICAL DATA AND MEASUREMENTS of physical properties for a large portion of container glasses have been collected each year since 1932. [1, 2, 3, 4, 5] The individual tabulations are, of course, confidential, but there is a great amount of information in the form of summaries and charts that can be presented without revealing sources. While by no means all the furnaces engaged in the melting of glass for containers are represented in the yearly summaries, the size and randomness of the samples appear ample to assure a satisfactory representation of the glasses made by the glass container industry of the United States.

The purposes of this report are to show the trends of glass compositions from 1932 to 1957, to show the ranges of compositions and of physical properties of glasses in use during 1957, and to show the influence of geographical location upon glass compositions.

Container Glasses 1932-1957

Previous reports have presented the trends in composition on a yearly basis. To simplify presentation, this report discloses trends by presentation of data at five-year intervals from 1932 to 1957. This procedure eliminates the minor year-to-year variations and allows a clearer view of the changes.

(a) Major Oxides

As in the past, the constituents are grouped. Silica is considered alone. Alumina, calcia, magnesia, and barium oxide are grouped as stabilizing oxides. Alkali, boric oxide, sulfate and fluorine are combined as fluxes. The average percentage compositions of glasses for these three groupings at five-year intervals from 1932 to 1957 are presented in Table I and illustrated in Fig. 1.

The silica content has declined steadily from 74.1 per cent in 1932 to 71.8 per cent in 1957, a decrease of 2.3 percentage units.

The total of the stabilizing oxides has increased steadily from 9.1 per cent in 1932 to 13.2 per cent in 1957, an increase of about 4 percentage units.

The alkali and minor constituents, grouped as fluxes, show a steady decrease from a value of nearly 17 per cent in 1932 to a value of 15.1 per cent in 1957.

TABLE I

Averages of Three Major Groupings 1932-1957

Year	SiO_2	Stabilizing Oxides	Fluxes
1932	74.1	9.1	16.8
1937	73.7	9.6	16.7
1942	72.8	11.3	16.0
1947	72.4	12.4	15.3
1952	72.1	12.5	15.5
1957	71.8	13.1	15.2

During the first several years of the period 1932 to 1957, the trends were scarcely significant. From 1937 to 1952, the rate of change of each of the three groupings was exceedingly rapid, with both the silica and flux groups being replaced by the stabilizing oxide group. A. K. Lyle[6] in a 1945 Service Bulletin reviewing the 1932-1944 container glass compositions stated, "There

TABLE II

Averages of the Minor Constituents 1932-1957

(Using only values representing intentional additions)

Year	R_2O_3	BaO	B_2O_3	F_2	SO_3
1932	1.3	0.7	—	—	0.2
1937	1.3	0.5	0.6	0.2	0.2
1942	1.7	0.4	0.6	0.2	0.2
1947	1.9	0.3	0.2	0.2	0.2
1952	2.1	0.5	0.4	0.2	0.2
1957	1.9	0.5	0.2	0.2	0.2

is, as yet, no indication of an end to the general trends, but it is certain that limits will be reached sometime. On the basis of extreme compositions showing minimum silica and alkali and maximum lime and alumina, the present rate of change (1932-1944) might be expected to continue for an additional ten years."

The present data show that, while the period 1947 to 1957 represents a marked slow-down of these trends, there still exists a trend for stabilizing oxides to replace silica. It is highly probable that substitution of stabilizing oxides for silica will continue to practical limits as long as the demand continues for glasses that will result in higher potential machine speeds. It is interesting to note that the 1957 container glasses, when considered by this grouping procedure, have a composition which is not too far removed from some window-glass compositions and that these compositions, when considered as container glasses, possess a high "relative machine speed."[7]

NOTE: The relative machine speed is calculated from the formula $M = \frac{(S\text{-}450)100}{(S\text{-}A)+77}$ where M is relative machine speed, S is softness temperature in °C and A is annealing point in °C.

TABLE III

Average Composition Container Glasses—1957

(Using Found Values)

	Per cent		*Per cent*
SiO_2	71.8	Silica	71.8
R_2O_3	1.9	Stabilizing	
CaO + MgO + BaO	11.2	Oxides	13.1
$Na_2O + K_2O + B_2O_3$	14.8		
SO_3, F_2	0.4	Fluxes	15.2
Fe_2O_3, Flint Glasses	0.058		
Fe_2O_3, Amber Glasses	0.168		
S, Amber Glasses	0.036		

(b) Minor Constituents

The minor constituents, such as alumina, barium oxide, boric oxide, sulfate and fluorine are employed in container glasses to impart desirable and improved characteristics to the basic soda-lime-silica compositions. Their use has been based upon the results of specific research investigations and upon results obtained in practice. The trends of the minor constituents are illustrated in Fig. 2. In all cases, the values shown are based on averages obtained from the total number of glasses in which the use of the particular ingredient was intentional.

With demand for glasses of increased chemical durability that appeared about 1937, the average value for alumina increased from 1.3 per cent to a value close to 1.9 per cent. Alumina is employed also to modify the working characteristics of glasses. Considering that the maximum resistance of glasses to chemical attack by water is attained when the percentage alumina is approximately one-eighth the percentage alkali,[8] it would seem that alumina is being used also to modify working characteristics or to make use of available raw materials.

The rise to 2.1 per cent alumina shown in 1952 can be attributed to the increased use of local high-alumina sands by the West Coast factories of the container industry. The return in 1957 to the 1947 value of 1.9 per

Fig. 1. Yearly average of glass composition used in the container industry (1932-1957).

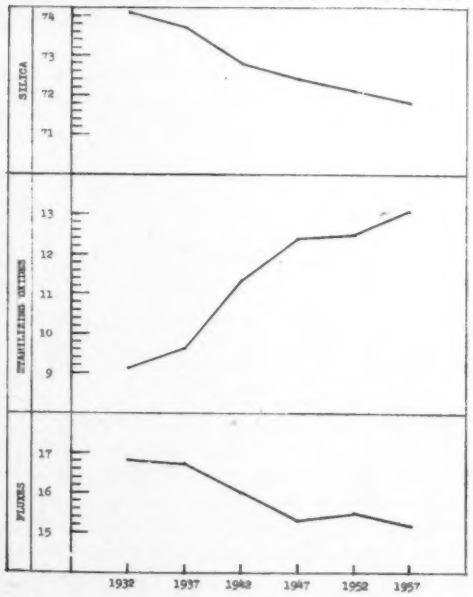
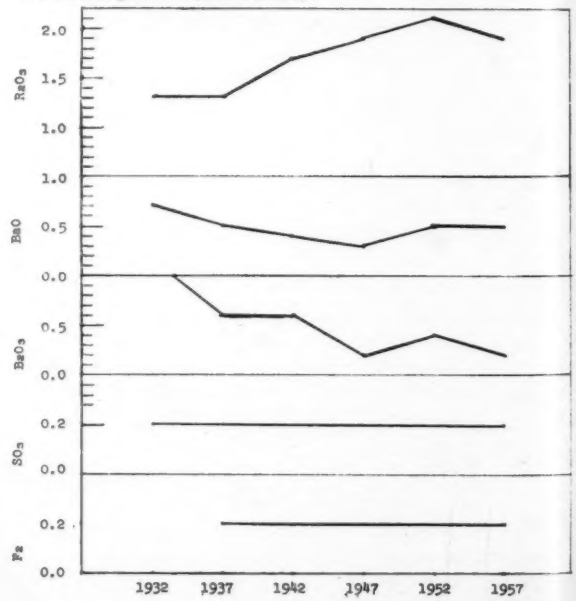


Fig. 2. Yearly average of the minor constituents used in container glasses (1932-1957).



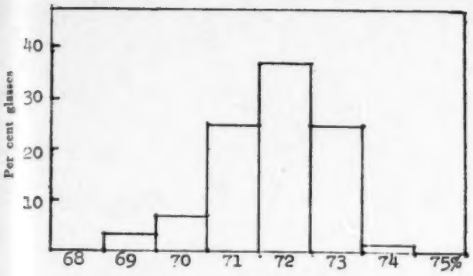


Fig. 3. Silica (SiO_2).

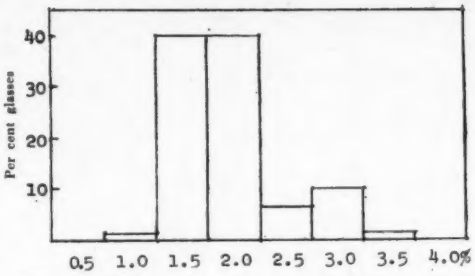


Fig. 4. Aluminum and iron oxides (Al_2O_3, Fe_2O_3).

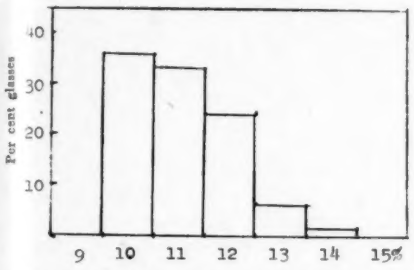


Fig. 5. Calcium and magnesium oxides CaO, MgO).

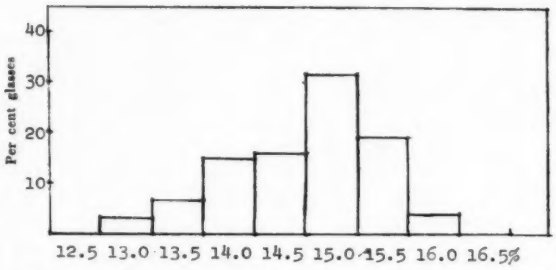


Fig. 6. Sodium and potassium oxides (Na_2O, K_2O).

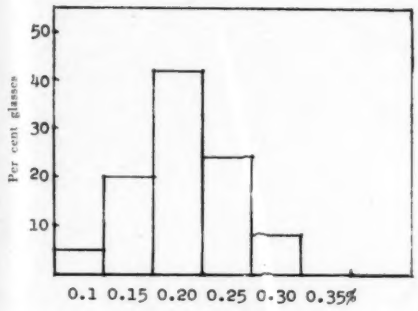


Fig. 7. Sulfate (SO_3).

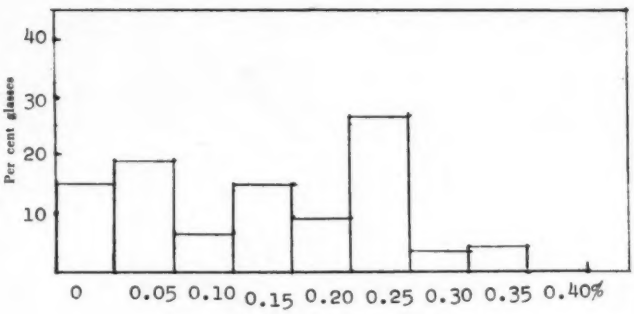


Fig. 8. Fluorine (F_2).

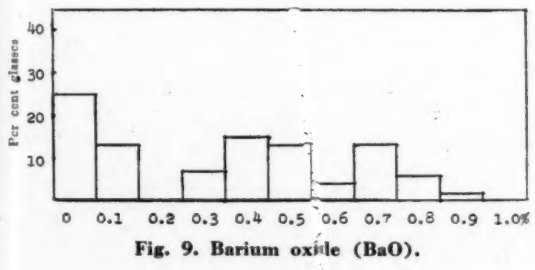


Fig. 9. Barium oxide (BaO).

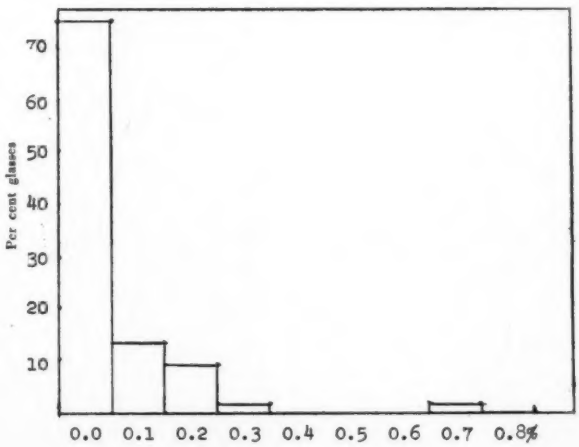


Fig. 10. Boric oxide (B_2O_3).

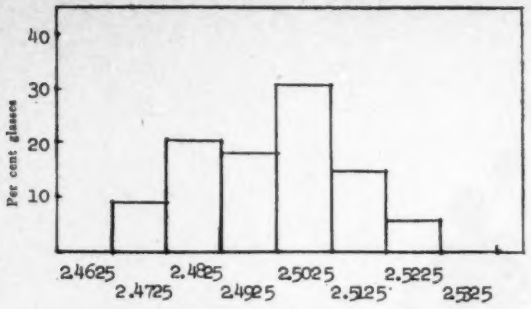


Fig. 11. Density (G/ cc./20°C).

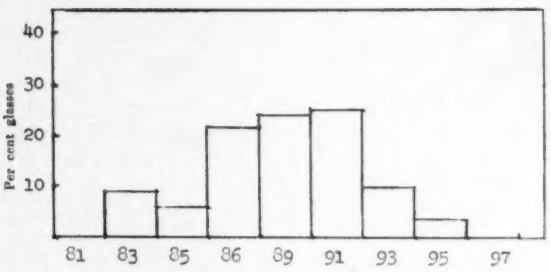


Fig. 12. Coefficient of thermal expansion X 10^{-7}.

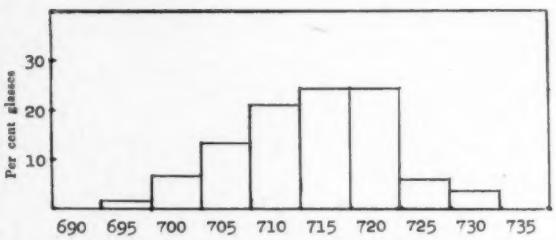


Fig. 13. Softness temperature °C.

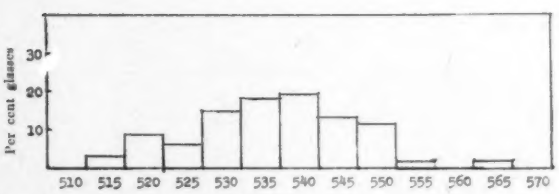


Fig. 14. Annealing point °C.

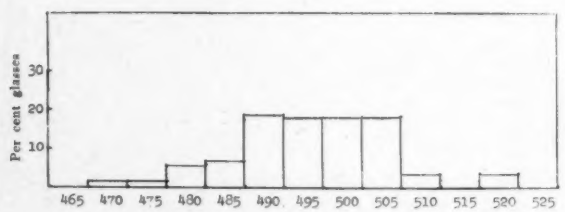


Fig. 15. Strain point °C.

cent alumina may be taken as an indication of the availability of sands of lower alumina content.

Barium oxide, after a downward trend from its highest value of 0.7 per cent in 1932 to a low value of 0.3 per cent in 1947, has become stabilized at a value of 0.5 per cent during the past five years.

This stabilized usage figure appears based on the experience that excess sulfate usually has an adverse effect on decolorization. Barium sulfate, being the usual source of barium, is therefore kept at a value that will yield approximately 0.5 per cent BaO in order to arrive at the most desirable percentage of sulfate.

In 1934, the first year all glasses were systematically checked for their B_2O_3 content as a result of this constituent being advocated for use in improving both chemical durability and meltability of soda-lime-silica glasses, it was found that, of the glasses containing intentional additions of boric oxide, the average content was approximately 1 per cent. By 1937, this had dropped to 0.6 per cent, where it remained through 1942. By 1947, a further decrease to 0.2 per cent had occurred. In 1952, there was an increase to 0.4 per cent, with a return to the 1947 value of 0.2 per cent in 1957.

Fluorine is one of the few minor constituents for which usage was first firmly established by laboratory measurements and tests, followed by successful large-scale production meltings. Its average value has therefore been steadily maintained at about 0.2 per cent in those glasses containing more than trace amounts.

Sulfate has been found in all of the flint and green glasses made from 1932 to 1958. Its average value is nearly constant at the 0.2 per cent figure. Again, it is fairly well established that the most effective proportion, in regard to its fining action, is about 0.2 per cent, regardless of whether the sulfate is introduced as salt cake, barytes or gypsum.

1957 Glasses

The average composition for container glasses manufactured in 1957 is shown in Table III. Sixty-seven furnaces are represented. While this is less than fifty per cent of the total number of furnaces engaged in the manufacture of containers, more than half of the manufacturers are represented. No attempt has been made to weigh the results according to the amount of production represented.

TABLE IV

Average Values of Physical Properties of 67 Container Glasses—1957

Density g/cc. at 20°C		**2.498**
Coefficient of Thermal Expansion 0-300°C, X 10^{-7}		**88.9**
Softness Temperature	**(log viscosity = 7.65)**	**714°C**
Annealing Point	**(log viscosity = 13.0)**	**536°C**
Strain Point	**(log viscosity = 14.5)**	**496°C**

Working Characteristics

Gob Temperature (log viscosity = 3.0)	**1212°C**
Working Range Index	**178**
Relative Machine Speed, per cent	**104**

Glass Quality Criteria

Homogeneity Grade	**B**
Seeds and Blisters Per Ounce	**30**
Blisters Per Ounce	**5**

Seventy-five per cent of the glasses shown in Table III are flint, twelve and one-half per cent are amber, and the remaining twelve and one-half per cent are Georgia (light) and emerald (dark) green.

Range of Compositions

The range of compositions used in 1957 is represented by distribution charts.

Silica. The silica content (Fig. 3) ranges from 68.5 to 74.5 per cent with the most common being 72 per cent.

Alumina. The distribution of the percentages of alumina is shown in Fig. 4. By far, the largest proportion of glasses contain 1.5 to 2.0 per cent alumina (Al_2O_3). The value of alumina in imparting improved chemical resistance is shown by the almost total lack of glasses having an alumina percentage below 1.5.

Calcium and Magnesium Oxides. As shown in Fig. 5, no glasses were found containing less than 9.5 per cent calcium plus magnesium oxides. The great majority of the 1957 glasses contain between 9.5 and 12.5 per cent of these two oxides with a few extreme values being found.

Sodium and Potassium oxides. A widespread value for the total of these constituents was found (Fig. 6) with the peak of the frequency curve being about 15.0 per cent (14.75-15.25 per cent range). A very few glasses contain as little as 13 per cent alkali and a very few contain as much as 16 per cent alkali.

Sulfate. The percentages of sulfate, Fig. 7, range from 0.075 to 0.325 with the most common being 0.20 per cent.

Fluorine. As shown in figure 8 more than 85 per cent of the 1957 glasses analyzed contained intentionally added amounts of fluorine. It appears that there are two general ranges of usage, one about 0.05 per cent and another about 0.25 per cent. The lower percentage seems to represent the usage of fluorine to prevent formation of blisters and bubbles caused by reaction between glass and refractories, while the higher percentage represents its usage for modification and control of working characteristics.

Barium oxide. The percentages of barium oxide (Fig. 9) range from 0.0 to 0.95 with the most common usage being in the 0.35 to 0.55 per cent range. The usage at the 0.10 per cent level appears to be the result of the use of foreign cullet in glasses to which barium is not added intentionally.

Boric oxide. As shown in Fig. 10, more than 70 per cent of the container glasses contain no boric oxide. Most of the glasses containing from 0.1 per cent to 0.2 per cent boric oxide represent additions included with the soda ash and are not strictly intentional. The values 0.3 per cent and 0.7 per cent B_2O_3 represent intentional boric oxide additions.

Physical Properties, Working Characteristics, and Glass Quality

All of the glasses examined chemically during the 1957 survey were subjected also to measurements of related physical properties and to calculation of working characteristics. The averages are given in Table IV. Distribution charts were prepared for each property or characteristic, and these are given in Figs. 11 to 21.

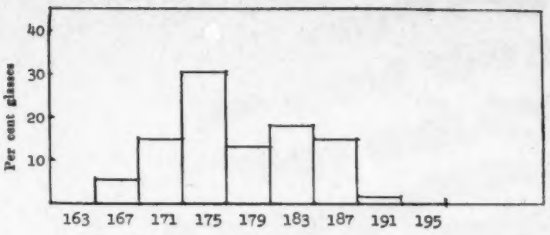


Fig. 16. Working range index.

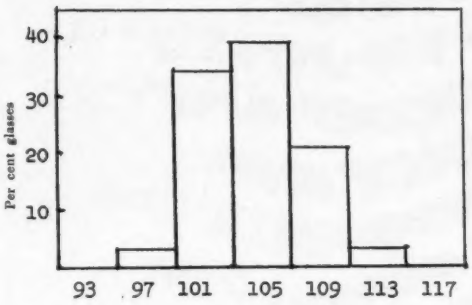


Fig. 17. Relative machine speed (per cent).

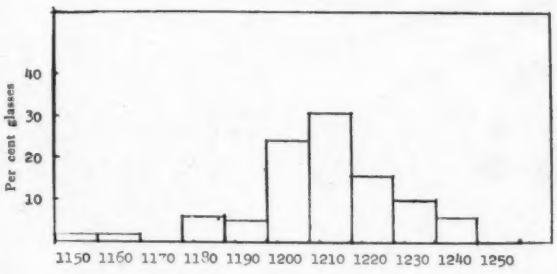


Fig. 18. Gob temperature °C.

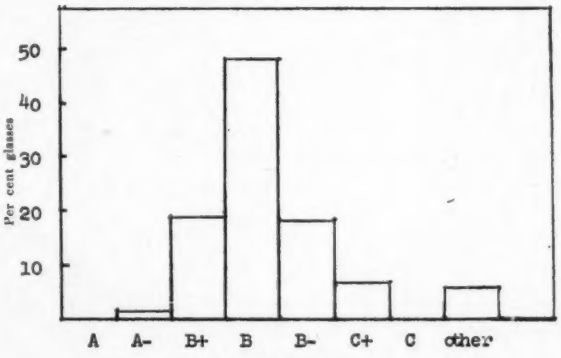


Fig. 19. Homogeneity.

Density. The densities of the glasses, expressed in grams per cubic centimeter at 20°C, are shown in Fig. 11. The values range from 2.4675 to 2.5275. Two peaks are present in the distribution curve, one at 2.4825 and the other at 2.5025. The two resulting and overlapping frequency curves correspond roughly to the density ranges of the dolomite and calcite glasses.

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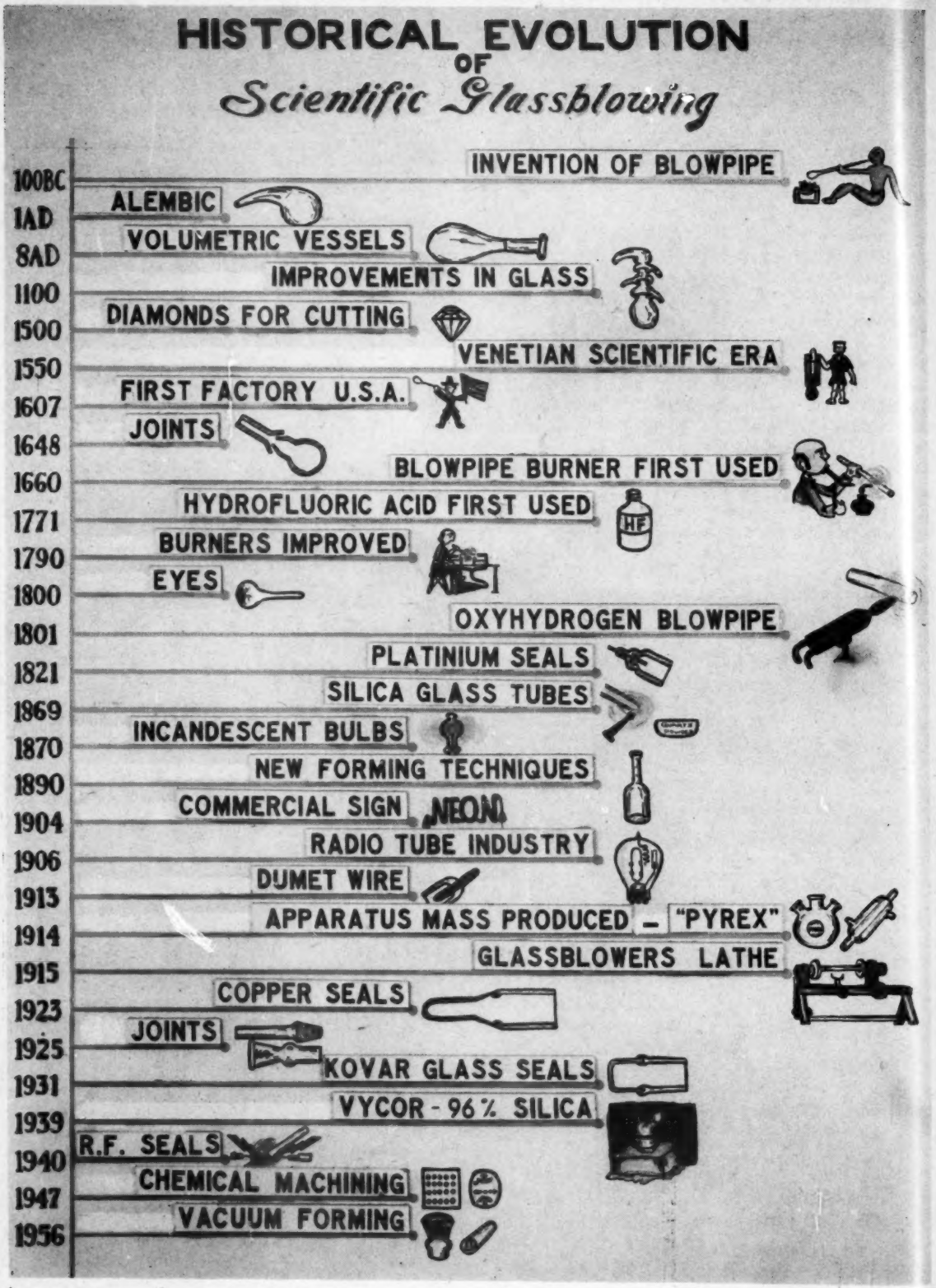

Fig. 1. Year refers to the first action or first popular use. Length of horizontal line indicates relative value of event to scientific glass-blowing field.

Highlights of Scientific Glass Blowing

By VINCENT C. DE MARIA
Glass Products Development Laboratory
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• SCIENTIFIC GLASS APPARATUS was originally made from molten glass and formed before the furnace which fused the raw ingredients. Glass was gathered on one end of a metal pipe, from pots within the white hot furnace and blown to shape by a skilled glass-blower or "gaffer." As laboratory apparatus became complex the molten glass was drawn into long tubes, in many sizes, for final fabrication.

The artisans who acquired the skill of manipulating softened glass tubing at bench burners were known as lampworkers. For years these tradesmen held their techniques secret, passing them on only within their family. With demanding requirements of two world wars, the introduction of glass lathes and improved burners, major changes resulted. With these changes came a new kind of lampworker, the scientific glass-blower, constructing glass apparatus in pace with the needs of the rapidly advancing sciences. An attempt is made in this article to show the responsibilities and subsequent change of some glass-blowers (gaffers) to lampworkers, and finally lampworkers to scientific glass-blowers.

Historical Review

The 5000-year history of glass making has been described in numerous publications. Silverman[1] and Goessl[2] cover the subject with extensive references. Glass forming by blowing, began with the invention of the blowpipe in about 100 B.C. Probably the first piece of scientific glassware blown was the alembic, or retort, used by the poor alchemist as a still in I A.D. (see chart, Fig. I) The shape suggests that the neck, of the then-popular round-bottom bottle, was allowed to sag to the desired curvature.

For the next one thousand years, glass stills and condensing tubes were made in a multitude of shapes and sizes[3]. During this period glass was a poor material for laboratory apparatus. The problem of contamination in distillation apparatus, from glass leaching, was confronted by the Medical School of Salerno in 1100 A.D.[4] At this time, the glass makers' efforts to obtain a more durable glass resulted in the first improvements in glass for scientific ware.

New techniques, to form intricate apparatus, were developed in many European areas. Porta's still, with its many tubulated alembics, made in 1550, is an outstanding example of work done with only the heat of the furnace, which melted the glass batch, and the hot exhaust gases. Ground joints, though heavy and crude, appeared on apparatus made in 1648.

However, the construction of scientific apparatus from gobs of glass and glory hole reheating became difficult, as chemists required more elaborate glassware. Then, in 1660, the tinned iron blowpipe, (similar to that now in use for charcoal block chemical analysis) was employed by Florentine glass-blowers as a bench-working burner. This transition, from factory furnace forming to fabricating apparatus with glass tubing at a bench burner 298 years ago, was the beginning of today's scientific glass blowing. The blowpipe produced a sharp hot flame and simplified the construction of complicated apparatus; consequently, the new glass-blowing burner spread rapidly through Europe.

But, blowing air by mouth into the blowpipe while blowing glass was awkward. Then, in 1679, Kunkel, a chemist, improved the operation by adding a foot-oper-

Fig. 2. Standard taper ground joints are checked for accuracy against master gages.

Fig. 3. Specialized workers tool glass tubing in cross fires to fabricate interchangeable joints.

ated bellows to blow the air required for the blowpipe.

Kunkel also contributed many of the early glass-blowing methods; these were described in his book *Ars Vitraria.*

In 1739, Cramer replaced the tinned blowpipe with a copper tube. By 1760, many chemists had become skilled glass apparatus makers. This was especially so in Sweden, where Cornstedt introduced the blowpipe to chemists working in analytical laboratories. Chemists like Forbern Bergman and his student J. G. Gohn (1745-1818) had outstanding glass-blowing abilities to form apparatus for wet-method analysis.

By 1790, the term "lampworker" signified a specific craftsman. During this year blast lamps were improved and crossfires introduced (Fig. I, chart, 1790). These burners, probably made from the oil lamps in use, were shallow, metal cans having a wick supplied with tree oil or lard oil fuel. Foot-operated bellows provided air to a metal tube (blowpipe) which was directed at the oil flame, just above the burning wick. Complicated soft glass work was made on these burners with exacting details.

An example of this detailed work was the glass eyes made in Germany in 1800 and 30 years later in Venice, by Puruzzi. To make these eyes a glass point was pulled and a ball blown from white glass tubing; the delicate pattern of the eye was then fashioned on top of the ball with colored glass rods. The glass flowers, made in 1850 by Leopold Bloshka and his son, are another outstanding example of detailed workmanship with similar burners. These true-to-life flowers, made in Germany, are on display at Harvard University.

With but a few exceptions, the manufacture of scientific glassware remained a European craft until 1890. During this year the Babcock butter fat test set a standard for the milk industry, and large quantities of testing apparatus were required[5]. This demand gave rise to a few small shops in this country and brought on improved production methods for blowing and engraving.

These small shops found it difficult to survive in 1894, the year Jena low-expansion borosilicate glass became available to the Bohemian and German glass-blowers. Jena laboratory apparatus[6], which could be used over an open flame, flooded this country. Some of the finest laboratory glassware was produced at low cost in European homes, making American competition almost impossible. The Tariff Act of 1913 offered little protection since it provided duty-free passage of glassware to universities, at that time the largest users of scientific apparatus.

The European monopoly continued until World War I, when imports were cut off. America was now faced with the problem of building a glass industry capable of supplying our scientific, electronic and optical requirements. Fortunately, making glass and furnace forming glassware was not foreign in this country. The first glass

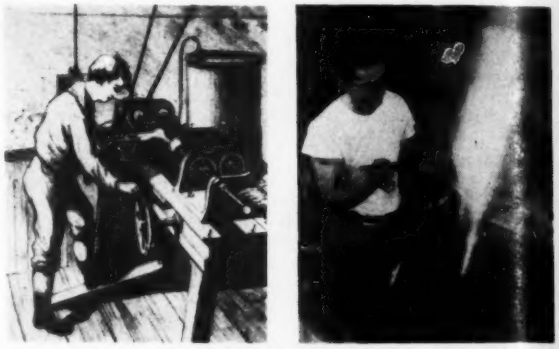


Fig. 4. First glass-blowing lathe (left), developed in England, made lamp bulbs. Modern glass-working lathes (Fig. 5, right) simplify large-diameter work.

factory was opened in 1607, in the colony of Virginia, at Jamestown. In 1765, scientific glassware was manufactured at some of the factories operated by Baron Heinrich Wilhelm von Stiegl. A major portion of the laboratory apparatus was made in South Jersey, selected for glass-making in 1825, because of fine sand, available fuel and railroads.[7]

Dr. Wheaton, a pioneer in this area, gave up his Millville drugstore and medical practice in 1888 to manufacture scientific glassware. Another South Jersey leader, Ewan Kimble, left Chicago in 1905 to buy the Vineland Tube Company; here he built machines for manufacturing ampules and supplied America with unlimited quantities. Automation was America's early contribution to the glass industry. This ingenuity now had to be applied to produce glass compositions and skills, equalling those in Europe.

Then, in 1914, after eight years of borosilicate glass research, Corning Glass Works announced Pyrex* Brand Glass. Heat resistant scientific apparatus could now be produced in the United States. The manipulating techniques, for making apparatus from tubing, were learned by many of the furnace workers. The wartime demands were supplied. After the war, imports again threatened the lampworkers, but now they were protected by revisions in the tariff act, made in 1922. However, glass apparatus making continued to be a guarded skill even in this country. The methods for obtaining new effects and simplifying operations were zealously hidden from fellow workers.

*The words Pyrex, Pyroceram, Vycor and Photoform used in this article are the trademarks of the Corning Glass Works, Corning, N.Y.

Cooperation among manufacturers of scientific apparatus had begun to exist. They had tried to standardize size and taper of ground joints beginning in 1918 but with little success. Finally, in 1929, these manufacturers, working with the National Bureau of Standards, provided detailed dimensions. The interchangeable ground joint system was established. The present edition, Commercial Standard CS21-58[8], includes standard dimensions for taper joints, stopcocks, stoppers and spherical joints. Precision master ring and plug gauges provide quality control checks on N.B.S. standards. (Fig. 2)

The quality of the finished joint depends, to a great extent, on a specialized glass worker, the tooler. (Fig. 3) Toolers form the joint shell from tubing with special forceps, equipped with template forms on the end of each arm and a center steel tongue to shape the inside. Each joint size requires a separate tool and master gauge.

The apparatus glassblower's secrecy soon limited his own progress. With rapid advances in glass technology, it became obvious that some means of disseminating technical information was necessary. The first planned program to improve the scientific glass-blowers knowledge of glass technology took place in England, in 1943. Professor W. E. S. Turner[9], international authority on glass technology, recognized the problem and held a four-class course for glass apparatus makers. This course, with Professor Turner's monograph, "The Elements of Glass Technology for Scientific Glass Blowers (Lamp-

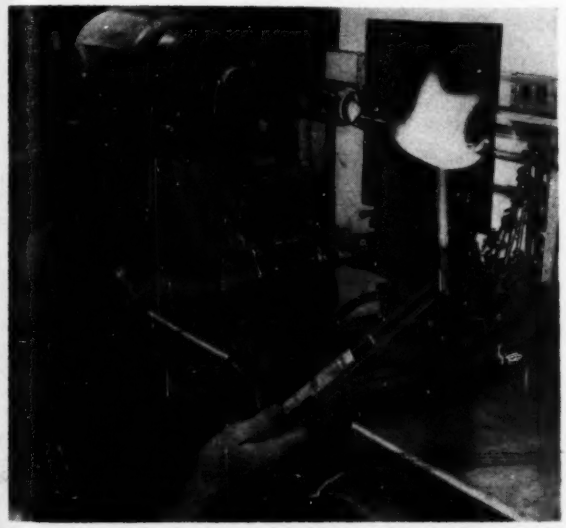


Fig. 6. Paddle forming glass with metal-working attachment produces precision outside diameters or tapers.

workers)" provided the necessary technical background for scientific glass blowing.

America's organized effort started in 1952, with a small group of glassblowers, headed by J. Allen Alexander. Two years later, they were chartered in the state of Delaware as the American Scientific Glass-Blowers Society[10]. Today, local area chapters exist across the United States; exchange of technical information takes place at meetings and through publications of the A.S.G.S. This Society, with over 500 members, is rapidly making the fabrication of glass apparatus a unified scientifically sound art.

Industry's Contribution

It was shown that the apparatus required by the early analytical chemists laid the foundation for scientific glass-blowing. The glassware required by the expanding fields of chemistry and medicine provided the glass-blower with a continued challenge of his skills. Perhaps of greater importance, it provided employment; many early items, such as Von Liebig's water jacketed condenser, invented in 1824, are still made today. The progressive growth of modern glass-blowing techniques, however, has been governed by advancements in many other scientific industries as well. A brief review of progress in these industries will reveal the origin of some of our present materials and methods.

Electronic and Illumination

These two great industries are grouped because of the similarity of glass fabricating operations. During the early years of incandescent lamp and radio tube manufacture glass blowers had a major role. It was their responsibility to blow the bulbs from tubing; seal on exhaust tubulations; make stems, and seal the stem which supported the mounted components, into the bulb.

The success of this industry's early inventors was aided by Davie's discovery, in 1821, of platinum-glass seals. This made possible the passage of an electric current into a hermetically sealed evacuated bulb.

Incandescent bulbs were made as early as 1870, but the industry got its start with Edison's first successful lamp in 1879 which was improved and commercialized by 1881. Two early problems were the high cost of platinum lead wires and the slow hand-forming methods. Material costs were lowered by using Dumet, a suitable substitute for platinum, invented by Eldred, in 1913. The production of small bulbs increased with the development of the glass-blowing lathe, which appeared in a few companies in this country about 1915. The glass-blowing lathe is the lamp industry's endowment to the field of modern scientific glass fabrication. Dr. Charles Eisler[11] provided the following information on the glass lathe, from his historical files on Lamp Making Machinery.

"The Swan Lamp Company of England manufactured an electric vacuum carbon lamp in 1878. As the

Fig. 7. Template forming rapidly reproduces a fixed shape without costly molds.

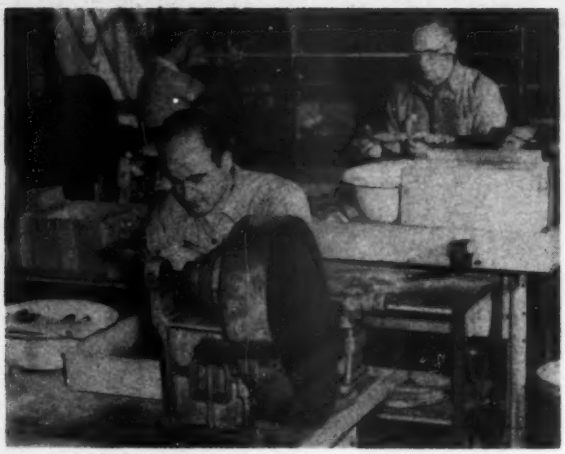


Fig. 8. These skilled grinders use a single-head lathe to grind stopcocks and joints on semi-finished apparatus.

Fig. 9. Many glass-grinding and polishing operations are performed rapidly on wet abrasive belts.

demand for this lamp increased, Mr. Swan, the inventor, engaged the services of two English Engineers, Frank Wright and M. W. Mackie, to develop a machine which would blow bulbs faster than hand forming. By 1880 the engineers had perfected a glass-blowing lathe with several advanced innovations. (Fig. 4). They supplied their improved crossfires and cannon burners with air and gas under pressure, eliminating the foot-operated air bellows. In addition, a half mold was provided that could be brought in contact with the hot rotating glass to shape a uniform bulb. With this lathe, production increased from 100 bulbs (per 12 hour day) for experienced help to 300 bulbs (per 10 hour day) by inexperienced boys. Some of these English lathes were exported to Russia in 1900.

"Another popular European glass lathe was patented in 1910 by John Kremenetzky, of Vienna, Austria, who received royalties from many European lamp companies for use of the machine.

"Still another occurrence in 1910, was the arrival of two Russian glass blowers, George Coby and I. Ignatoff, who settled in Newark, N.J., and started a bulb-blowing business. Soon after they were supplying the McCandle Lamp Company of Brooklyn with lathe-made bulbs. Their lathe was duplicated, and a number of them made for the McCandle Lamp Company."

Without the aid of glass-blowing lathes it would be humanly impossible for the scientific glass blowers to construct the large-diameter apparatus required by today's scientist (Fig. 5). Other features of the lathe, which make it as important as bench-working burners, are accurate alignment and close tolerance glass working.

Precision glass parts can now be produced, to match corresponding machined metal parts, by securing a metal working lathe milling attachment to the burner carriage of a glass lathe. (Fig. 6). Carbon plates or graphite-coated steel templates, used for forming, are rigidly supported in the milling attachment vise. These forming paddles are operated by a feed screw which can be moved in increments of one thousandth of an inch. Exact angles can also be obtained with this milling attachment, for reproducing glass pipe flanges and special taper joints, without costly tools. Any configuration that is made by rotation in a mold or hand tool can be duplicated.

The ease of setting up for a few parts makes the mill-

(Continued on page 662)

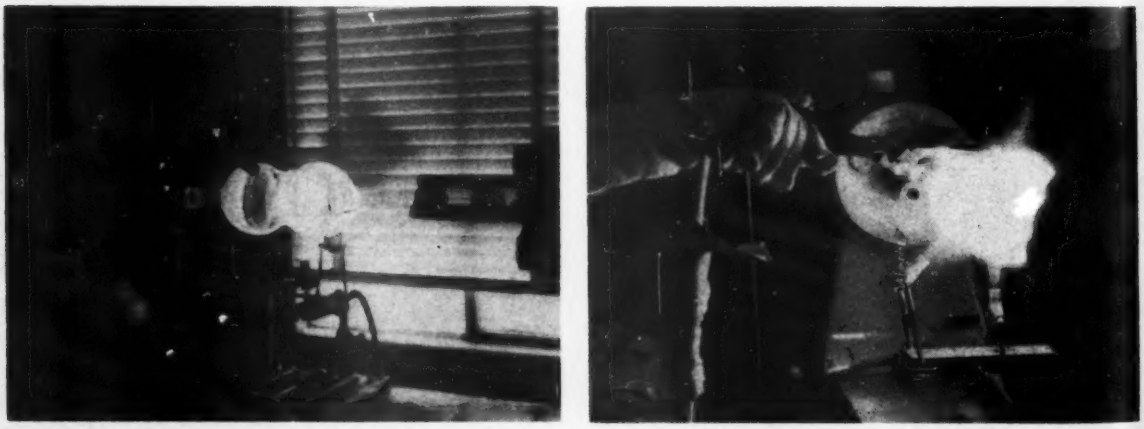


Fig. 10. Improved burners seal fused quartz flasks (left) to produce 7-inch cylinder (right) for high-purity chemical reaction container.

A.C.S. West Coast Meeting

ABOUT 600 CERAMISTS attended the Eleventh Pacific Coast regional meeting of the American Ceramic Society (October 22 to 24) at the Ambassador Hotel in Los Angeles. Theme of the 3-day meeting was "World of Tomorrow," with emphasis on competition in technical advancement.

Tank Performance

The glass division papers covered many aspects of glass manufacture. Harold Baque, Corhart Refractories, reported on the outstanding performance of the container glass tank at Hayward, California, owned by the United Can and Glass Company, which operated continuously over five years, with an average daily pull of 4.7 square feet per ton of glass.

Fuel consumption averaged just below six million B. T. U. per ton of glass. Fused-cast refractories were used generally throughout the side walls and furnace upper-structure, also the port necks. About one-half of the melting end bottom was paved with 4-inch fused cast, and the checkers and regenerator upper-structure were of basic material.

Mr. Baque discussed contributing factors such as alumina content of the glass, operating temperatures, seed count, and glass homogeneity. Favorable factors included steady pull with few job changes, lower-than-average melting temperatures, and unusually good attention in operating the tank. It was stated that the life of many other tanks would be lengthened if other manufacturers incorporated good design, good refractories, and constant attention in their operation. All of these are elements of a profitable operation.

Refractories

The new Walsh fused cast block, FC-101, is one of the three recent developments by Walsh Refractories Corporation. These three materials were discussed in a paper prepared by Frank C. Steimke entitled "Research and Development at Walsh Refractories Corporation."

FC-101, which will be available to industry in 1959, is distinctly a competitive material in the fused cast field. It consists of about 52 per cent alumina, 13 per cent silica, and 35 per cent zirconia, with traces of minor ingredients. It is claimed that the crystalline composition of the material can be carefully controlled so that the glassy phase will be highly refractory. This is done by selecting raw materials with a low iron oxide content, and containing only trace amounts of titania, lime, and magnesia.

In pilot plant operation castings have been made up to 1½ cubic feet with remarkable control of shape. The FC-101 block have been tried out in corrosion furnaces and results show shallow metal-line cut-back, also a minimum of spalling.

Another recent development is Zircon paving block, used to extend tank life and produce glass with a minimum of bubbles and blisters. Slides were projected for the purpose of showing interfacial reactions when using various kinds of glass, including opal and borosilicate. This material is used primarily as paving and upper structure materials, drip courses in silica crowns, and in shadow walls.

The third refractory discussed was Insulflux, which has some of the corrosion-resisting properties of a clay flux block, and the low K factor of an insulating brick. Insulflux, it was reported, has good insulating properties and high mechanical strength, for materials of this kind.

Annealing Glassware

Frank E. Dorsey, Hartford-Empire Division of the Emhart Manufacturing Company, discussed recent developments in equipment for annealing glassware. Since 1953 there have been increasingly severe demands on lehrs and associated equipment, the result of a step-up in the speed of many I. S. machines by about 20 per cent. Another reason is the demand by the glass industry for ware of better quality.

To meet these requirements The Hartford Empire Company recently introduced into service the 125 Annealing Lehr, and the 139 Decorating Lehr.

Both lehrs make use of a six-foot-wide belt so as to provide greater annealing or decorating capacity. The 139 Lehr has a greater number of burner controls than earlier lehrs so as to provide a positive firing schedule. This permits increased loads and better control of the process.

The 125 Lehr is designed to accommodate an Automatic Thermal Shock Tester, which is installed in a special eight-foot section just beyond the annealing zone. Each container is subjected to a blast of air. The temperature is adjusted to provide the thermal shock required for the particular type of ware being tested.

Ware with bad baffle marks and with base-rim and other checks will break. One of the problems is to establish the best thermal shock differential for various

ware types. As a supplement to the thermal shock test, equipment is available for also submitting the ware to an internal pressure test. This combination has been particularly successful for testing pressure bottles where it is necessary to eliminate those that might break in such operations as sterilization, and filling.

Mr. Dorsey discussed single-line inspection equipment, also a check scanning device, which, along with other auxiliary equipment, may ultimately make it possible to inspect bottles and jars automatically. Reference was made to the increasing use of silicones and waxes for spray-coating glassware. Some of these coatings require bottle temperatures of 175°-200°F.

Glass Manufacturing Problems

Pertinent glass manufacturing problems were discussed by V. C. Swicker, with particular reference to glass composition, glass-making operations, manipulation of the glass, quality control, and responsibility for defectives.

Glass as a material has remarkable potentials. It is possible, first of all, to make better use of many present compositions, even to the extent of increasing speeds by over five per cent. It is possible to modify present compositions, to get better production through improved properties, and through research and development activities entirely new compositions will be developed with controllable properties.

There are many problems of manipulation. The glass must be consistently more uniform, temperature control must be more positive in many plants, and the operators must run the forming machines more efficiently. In addition, more knowledge is necessary of the chill pattern in bottle forming, and about the vertical flow of heat in the walls of the plunger.

The problem of quality control as it applies to outgoing bottles involves the packing room department, where about 50 per cent of the labor force is located. This is an area where it should be possible to effect a sizeable savings; however, much more development work remains to be done before all sub-standard bottles are "weeded-out" from the production line.

Mr. Swicker discussed the need for assigning responsibility for the detection of defects to the area where the defects originate, and supported his comments with a chart designed to stimulate interest in this important means for lowering costs.

The most important manufacturing problem for 1959, in his opinion, pertains to the abilities of men. There are organizational weaknesses in many plants. Part of the operating staff has not been adequately trained. This is a problem that will handicap future production. In discussing means for correcting this situation, charts were projected for use in developing both production and technical men. It is certain that competition in technical advancement will dominate 1959.

Control of Glass Quality

R. W. Hopkins discussed "Yardsticks in Glass," citing the need for more positive measuring devices in the control of glass quality and properties, the need for a better knowledge of the chemistry of glass, and a better understanding of the Periodic Table. In regard to the chemistry of glass, Mr. Hopkins stressed the use of chemical equations, particularly those dealing with oxidizing and reducing reactions. One of his examples was the relationship between sodium sulphate and gypsum in a flint glass batch:

6 lbs. Salt Cake = 7 lbs. Gypsum

Mr. Hopkins stressed the importance of maintaining the most favorable atmosphere over the glass in the melting end and pointed out that for some glasses a slightly reducing condition is necessary, whereas for others an oxidizing atmosphere is necessary, for the best operation. In referring to the difference in tanks, the statement was made that theoretically each furnace might need a different batch in order to operate at top efficiency, and that as the tank aged it is often necessary to modify the batch. These are factors not usually recognized.

The author quoted values for the flow of glass in 20" deep tanks, and stressed the need for more information on the surface of the glass back of the bridge-wall. In predicting future trends, he mentioned the value of small tanks, and suggested that sometimes portable tanks may be available for installation in customers' plants, with the result that the glass batch would be "tailor-made."

Mr. Hopkins showed light transmission measurements of both amber and emerald green glasses, stating that corrections can be made to fit a "standard," and that there will be no guess-work connected with it.

Surface Coatings

In a paper entitled "Silicones for Surface Protection," T. J. Mahoney listed some of the properties that the glass manufacturer can expect to find in anti-seize agents. First of all the material must have good lubricity; it must be easy to use; it must be suitable for a wide range of temperature application; inexpensive; be labelable, and finally it must be analyzable. An analytical method was outlined.

A test method, in the form of static friction apparatus, was described, and considerable experimental data presented, including ultra violet transmission. As the result of the protective qualities of some of these coatings many packers now specify that their ware be spray-coated.

Basic Refractories

"Trends of Basic Refractory Applications" was the subject discussed by Edward P. Vincent, who stated that the use of these materials is economically justified. He reviewed current uses, and predicted future changes in respect to use applications.

Mr. Vincent said the basic refractories should be installed to a depth corresponding to the melting point of sodium sulphate. This "horizon" is slightly less than 1600° C. If, for example, there are 50 courses of brick in the checker chamber, 40 of these courses should be of basic brick. The basket weave is recommended.

There is a trend toward more and deeper settings in the checkers chamber. The use of more basic brick in the super-structure will prolong tank life. New refractories are now being developed which should give even better tank life.

(*Continued on page* 662)

Recent Translations of Russian Papers of Interest to the Glass Industry

Mathematics of grinding and polishing sheet glass

In *Steklo i Keramika* (Glass and Ceramics) *13*, No. 8, p. 6 (1956), P. Ya. Bokin presents some simple expressions for predicting the results of grinding and polishing sheet glass in the plant.

The first problem concerns the thickness of the glass layer removed during the coarse grinding, the fine grinding, and the polishing. The first thickness is determined by the waviness of the initial glass sheet. For the second layer, the equation

$$h_1 = k\ (D_m - D_1)$$

is proposed; in it h_1 is the thickness of the layer removed during fine grinding, k is a constant (which for a cast iron polishing disc and sand abrasives was 0.70), D_m is the diameter of the sand grains used for coarse grinding, and D_1 is the diameter of the smallest grains used in fine grinding. The thickness of the layer removed during polishing is KD_1.

The second problem is that of grinding time. The thickness removed in unit time is

$$\Delta = \beta A_1 A_2 A_3 Pn\ (1 - e^{-aD}).$$

In this equation, β is a general constant (depending, for instance, on temperature). A_1 depends on the material of the grinding disc; the values of A_1 for cast iron, methyl methacrylate, and vinyl plastic disc, e. g., were in the ratio 1:0.29:0.25. A_2 depends on the glass treated and may vary in the ratio 1:2.

The coefficient A_3 represents the effect of the nature of the abrasive; e.g., it changes in the ratio 1:2.5 when corundum is substituted for sand. The pressure on the disc is P, and n is the rate of its rotation. The meaning of the above equation is that all the above-mentioned factors are independent of each other; for instance substitution of cast iron for vinyl plastic will increase the rate of glass removal four-fold, whatever the values of A_2, A_3, P, and n. The constant depends on the unit in which the grain diameter D is expressed.

The number of different powder fractions needed for fine grinding can be calculated if Δ, the time of application of each fraction and the ratio of grain diameters for subsequent fractions are known.

Measurement of stresses in sheet glass

V. L. Indenbom criticizes in *Steklo i Keramika* (Glass and Ceramics) *13*, No. 9, p. 18 (1956), the usual photoelastic testing of glass sheets and advocates the determination of stress differences along the width of the ribbon.

These stress differences can be seen if the light beam is directed perpendicularly to the main surfaces of the glass ribbon, that is through the smallest dimension (= thickness). If the y coordinate is directed along the width of the ribbon (that is normally to the withdrawal direction and to the thickness) and if y is zero along the center line of the ribbon, then the stress in the withdrawal direction (σ) varies with y because the glass temperature during the withdrawal was not constant over the whole width of the ribbon. Let T be this temperature at any point. Then,

$$\sigma = a\ E \left(T_m - T + y \frac{(yT)_m}{(y^2)_m} \right)$$

In this equation, a is the coefficient of heat expansion of glass, E its modulus of elasticity, T_m is the average temperature of the ribbon over the whole width, and $(yT)_m$ and $(y^2)_m$ are the analogous average values.

The above equation was applied to some literature data on the temperature distribution across a glass ribbon during withdrawal. At the edge of the ribbon, that is for $y = b$ if $2b$ were the total ribbon width, the equation gave stresses of 0.5 to 4.2 kg. wt./sq. mm. (or 700 to 5900 psi). Thus, these stresses often were greater than those in the thickness of the ribbon, which are detected by inspecting the glass from one narrow face to the other.

The author measured the greatest path difference visible on inspecting glass sheets (5 mm. thick) from one large face to the other large one. In 14 instances out of 50 this difference was greater than 120 millimicrons per centimeter. In many sheets, the path difference did not regularly increase from the center line of the sheet toward the edges, but had a secondary maximum at, e. g., 6 cm. from the sheet edge.

If the two large surfaces of a glass ribbon during withdrawal had different temperatures, the asymmetry has no effect on the stress distribution detectable by the usual examination (i. e., with light beam being parallel to the y axis). The opposite statements found in the literature are incorrect. However, examination with a light beam perpendicular to both y and the withdrawal direction permits determination of the stresses caused by the above temperature difference. If T_1–T_2 is this difference, the stress along the circumference of a circle cut out of the ribbon is

$$\sigma = \frac{E}{6} \left(\frac{a\ r}{d} \right)^2 (T_1 - T_2)^2$$

r being the radius of the circle and d the thickness of the ribbon. An experimental a was, for instance, 3.5 kg. wt./sq. cm. (or 49 psi). From the above equation, the temperature difference between the two glass surfaces was 23°C.

Native quartz dust in glass making

A. I. Zhilin suggests, in *Steklo i Keramica* (Glass and Ceramics) *13*, No. 9, p. 26 (1956), utilization of the

(*Continued on page* 671)

Speakers who took part in workshop program at Bedford Springs in October are, front row, left to right: W. R. Lester, Emhart Manufacturing Co.; E. H. Hamilton, National Bureau of Standards; S. A. Pozzanghera, Bausch & Lomb Optical Co.; R. G. Grimm, Pittsburgh Plate Glass Co.; T. B. O'Connell, L-O-F Glass Co.; W. G. Halloin, Pittsburgh Plate; and W. H. Otto, Owens-Corning Fiberglas. Back row: E. C. Hagedorn, Owens-Illinois; N. M. Hudak, General Electric Co.; H. E. Hagy, Corning Glass Works; J. W. De Remer, American Saint Gobain; J. E. Duncan, Pittsburgh Plate; and J. T. Stirrup, Brockway Glass Co.

Glass Division officers, left to right: Neill M. Brandt, Mellon Institute, chairman; Frank R. Bacon, Owens-Illinois, vice chairman; Fay V. Tooley, University of Illinois, secretary; Leonard G. Ghering, Preston Laboratories, trustee; Robert D. Maurer, Corning Glass Works, and Clarence L. Babcock, Owens-Illinois, both on the program committee; and Ralph K. Day, L-O-F Glass Fibers Co., chairman and member of the program commitee.

PPG INTERNATIONAL

Pittsburgh Plate Glass Company has set up a new International subsidiary known as Pittsburgh Plate Glass International S.A. This wholly owned subsidiary is a Swiss corporation with home offices in Geneva.

Function of the subsidiary is to integrate all phases of international business of Pittsburgh Plate, including licensing, investment, manufacturing and marketing functions.

Eventual plans are expected to include facilities for the production of glass, paints and related products.

A. B. Wilson

WILSON APPOINTED BY H-B

A. Brent Wilson, vice president since 1955, has been appointed executive vice president of Harbison-Walker Refractories Co. A. L. Garber continues as president and chief executive officer.

Mr. Wilson first became associated with Harbison-Walker in 1934 when he joined Canadian Refractories Limited, the company's subsidiary in Canada. In 1948 he was named general manager and two years later was transferred to the parent company, becoming vice president in 1955.

TOLEDO AWARD TO DR. SLAYTER

Dr. Games Slayter, vice president in charge of research and development of Owens-Corning Fiberglas Corp., will receive the 1959 Toledo Glass and Ceramic Award. The presentation will be made at a dinner in the Toledo Club of the Northwestern Ohio section of the American Ceramic Society on January 19.

Dr. Slayter, often said to be the father of Fiberglas, joined Owens-Illinois Glass Co. in 1931 in Toledo when he began developing a commercial process for manufacturing glass fibers. Today he has more than 125 patents to his credit, most of which are in the glass fibers field.

He became vice president in charge of research and development in 1938 when Owens-Corning was organized. He has won many awards for achievement in industry and engineering, having received both the Longstreth Medal of Franklin Institute and the Modern Pioneer Award of the National Association of Manufacturers in 1940, the Industrial Research Institute Medal in 1948 and the Ohio Award of the American Institute of Chemists in 1953. He received a distinguished citizen citation in 1956 from Denison University for his contribution to science.

HAZEL-ATLAS APPOINTMENTS

John W. Cooper has been named manager of the Hazel-Atlas Glass Division plant of Continental Can Company in Plainfield, Illinois. He had previously been with Owens-Illinois Glass Company for 31 years.

Roy B. Downey is manager of the Hazel-Atlas Glass Division plant in Zanesville, Ohio, succeeding Fred N. Peregoy who has retired. Mr. Downey was formerly division manager of industrial engineering at Hazel-Atlas.

DR. WILLIAM C. TAYLOR

Dr. William C. Taylor, honorary vice president and general technical adviser of Corning Glass Works, died in his sleep at his home in Corning, N.Y. on November 2. He was 72 years of age.

He had been honored on October 28 at a dinner marking the fiftieth anniversary of Corning's research laboratory.

Dr. Taylor held 32 patents, mostly in the field of glass composition and, with Dr. Eugene V. Sullivan, was coinventor of heat- and corrosion-resistant glasses, later marketed as Pyrex.

He graduated from Massachusetts Institute of Technology in 1908 and received an honorary Doctor of Science degree from Alfred University. In 1908 he began as an assistant chemist at Corning, becoming a chemist in 1910, chief chemist in 1923, director of glass technology in 1939, vice president (1943) and director of manufacturing and engineering (1947), and honorary vice president and general technical advisor in 1954. He was also a director of Corhart Refractories Co.

The Howard M. Potts Medal of Franklin Institute was awarded to Dr. Taylor in 1928 for new heat-resistant glass. He also received the Perkins Award in 1929 and the Modern Pioneers of Industry Award, National Association of Manufacturers, in 1940.

Inventions and Inventors

Annealing and Tempering

Apparatus for surface-treating ampuls. Patent No. 2,843,958. Filed June 8, 1956. Issued July 22, 1958. No sheets of drawings; none reproduced. Assigned to Owens-Illinois Glass Company by William E. Hughes, Jr.

The present invention relates to improvements in apparatus for surface treating the interior of glass ampuls and more particularly is a device which functions to increase or lengthen time interval during which an acidic gas may be introduced into newly formed ampuls during their continuous travel from a forming machine to an annealing lehr.

It is common practice to introduce an acidic gas, sulphur dioxide for example, into the open ends of glass ampuls just prior to placing them in an annealing lehr to the end that the objectionable effects of alkali at the surface of the glass may be neutralized. Subsequent heating of the ampul completes the neutralizing operation.

A fixed camming and holding device is provided which will quickly advance the stem end portion only of each ampul relative to its propelling means into a position of registry with the gas injecting nozzle and hold the stem end in such position until said propelling means again engages the stem end of the ampul and removes it from the holding influence of the cam device.

The stem end portions of ampuls are held in a predetermined zone of their travel to the annealing lehr for a period of time in register with a stationary gas-injecting device positioned at one side of the path of travel of the ampuls.

There were 5 claims and the following references cited.

United States Patents

2,036,647, Achauer et al., Apr. 7, 1936; 2,088,542, Westin, July 27, 1937; and 2,353,519, Spurr, July 11, 1944.

Foreign Patent

584,802, Great Britain, Jan. 23, 1947.

Feeding and Forming

Method of forming and fusing glass articles. Patent No. 2,807,122. Filed May 26, 1954. Issued September 24, 1957. Two sheets of drawings; none reproduced. Assigned to American Optical Company by Lee O. Upton.

This invention relates to improvements in fused glass articles and has particular reference to the method of controlling the interfacial characteristics of the heat-joined surfaces of such articles.

It has been found in the art of preparing glass surfaces for fusion with each other, particularly in forming fused blanks for multifocal lenses that hydrated silicate surface films form which later decompose on heating forming bubbles in the fused blanks and thus rendering the lenses unsuitable for use.

A novel method is given for treating said pieces of glass by refrigeration to dehydrate said surfaces and thereafter heat-joining said surfaces within a time interval so controlled as to avoid adsorption of moisture from the atmosphere and the forming of a hydrated silicate film on said surfaces. The improved method is said to produce an improved lens.

There were 5 claims and the following references.

United States Patents

1,647,785, Coughlin, Nov. 1, 1927; 2,089,261, Hopkins, Aug. 10, 1937; and 2,640,299, Sheard, June 2, 1953.

Furnaces

Forehearth bowl temperature control means. Patent No. 2,830,107. Filed December 20, 1954. Issued April 8, 1958. No sheets of drawings; none reproduced. Assigned to General Electric Company by Clarence E. Hahn, Willoughby, and Sigmund Meieran.

The present invention relates to an apparatus for maintaining the proper temperature distribution in the discharge bowl of a forehearth of a glass furnace.

A common and often serious fault of the bowl portions of glass furnace forehearth is in their inability to maintain a uniform temperature within the molten glass therein. As a result, the glass issuing from the discharge orifice at the bottom of the bowl is not homogenous and has cords.

Apparatus is provided for heating the molten glass in the end bowl of a forehearth by the passage of electric current therethrough and to effect the heating operation in a manner to compensate both for the heat lost by the glass to the end walls of the bowl and for the heat not received by the glass due to the shadow effect of the flow control needle of the forehearth which intercepts heat radiated from the channel portion of the forehearth. A further object of the invention is to provide such heating apparatus capable of providing additional heat quickly to the molten glass in the end bowl of the forehearth to compensate for temporary fluctuations in the temperature of the molten glass entering the bowl.

There were 2 claims and the following references cited in this patent.

United States Patents

1,458,522, Clark, June 12, 1923; 1,680,543, Howard, Aug. 14, 1928; 2,179,224, Soubier, Nov. 7, 1939; 2,186,718, Ferguson, Jan. 9, 1940; 2,276,295, Ferguson, Mar. 17, 1942; 2,283,800, Ferguson, May 19, 1942; and 2,591,709, Lubatti, Apr. 8, 1952.

Glass Compositions

Glass-bonded ferrite. Patent No. 2,820,720. Filed September 15, 1954. Issued January 21, 1958. No sheets of drawings; none reproduced. Assigned to Hughes Aircraft Company by Arthur H. Iversen.

The invention relates to vitreous-coated ceramics and,

more particularly, to a glass bond for porous magnetic materials and a method of making such a bond.

An object of the invention is to provide a bond between a porous ferrite and a thin glass coating having a low-loss and a method of providing such a bond.

The following method is a typical process which may be employed to seal porous ferrite without substantially increasing its loss:

1. Apply a ferrite powder having a 5-micron particle size to a porous ferrite body by painting or spraying a suspension of the powder in water onto the external surface of the ferrite body.
2. Sinter the ferrite powder and body in air at 1000°C for ten minutes.
3. After allowing the ferrite body to cool, paint or spray a liquid suspension of Corning glass 7570 in water onto the sintered layer of the ferrite powder.
4. Flow the Corning glass 7570 by heating it to its sintering temperature, which may be between 550° to 750°C, for about ten minutes.

Alternately methyl alcohol may be employed as the glass or ferrite powder suspending medium.

The glass designated 7570 by the Corning Glass Works and sometimes called "solder glass" is a glass which exhibits certain satisfactory physical properties for sealing a ferrite, in that it is desirable to use a glass having a sintering temperature below that of dielectric powder which Corning glass 7570 has. This glass also has a low-loss factor and high coefficient of expansion.

There were 6 claims and the following references cited in this patent.

United States Patents

2,330,129, Lucas, Sept. 21, 1943; 2,568,881, Albert-Schoenberg, Sept. 25, 1951.

Foreign Patents

620,009, Great Britain, Mar. 17, 1949.

Glass and Wool Fiber

Method and Apparatus For Producing Reticulated Fibrous Product. Patent No. 2,797,728. Filed November 23, 1949. Issued July 2, 1957. Five sheets of drawings; none reproduced. Assigned to Owens-Corning Fiberglas Corporation by Games Slayter and Warren Wendell Drummond.

The present invention involves a novel method of producing a reticulated or fabric-like product of continuous fibers or strands disposed in different directions which are assembled in intersecting relationship without interlacing or weaving. The resultant strength factors in various directions of the composite product may be controlled through directional and symmetrical orientation of the strands or fibers making up the end product.

The method includes the steps of moving a group of spaced mineral fibers in one direction, moving a fiber in a different direction and depositing it upon the fibers of the group to cause the fiber to be overlaid upon and in intersecting engagement with the fibers of the group, and joining the fibers together at their zones of intersection.

The product formed of unwove intersecting strands is admirably adapted as a reinforcement of medium for incorporation in resin films of all types, molded plastics, laminates formed of vegetable matter or resinous material, calendered or immersed sheet material, reinforcements for paper sheets or reinforcement for laminated papers or other fabricated sheets of fibers or fabricated materials.

There were 22 claims and 14 references cited in this patent.

Sheet and Plate Glass

Endless Conveyor. Patent No. 2,796,707. Filed December 29, 1953. Issued June 25, 1957. Three sheets of drawings; none reproduced. Assigned to Sommer & Maca Glass Machinery Company by Raymond Meter.

This invention relates to an endless conveyor that is to be used for conveying flat glass plates past a polisher, or abrader, for working on the edges thereof.

From the foregoing, it will be seen that it affords a pusher in a conveyor which is adapted to hold plate glass planes in assembled groups, the grippers in each pusher serving to align the panes in spaced parallel relatation. The pusher also includes at either end a latch having a lip for engaging the edges of the conveyor, and this lip is biased, preferably by means of a spring, to thus hold the pusher releasably on the conveyor so that the pusher is retained against displacement when the conveyor is reversed from the upper to the lower run.

There were 9 claims and 10 references cited in this patent.

Apparatus for grinding the bottom surface of a ribbon of glass. Patent No. 2,809,479. Filed May 3, 1955. Issued October 15, 1957. One sheet of drawings; none reproduced. Assigned to Societe Anonyme des Manufactures des Glaces et Produits Chimiques de St. Gobain, Chauny & Cirey, Paris, France, by Armand Lamesch.

The present invention relates to apparatus for simultaneously grinding both surfaces of a ribbon of glass.

A well known form of apparatus for simultaneously grinding the two surfaces of a ribbon of glass comprises coaxial tools each including circular grinding discs mounted to rotate around vertical axes and arranged in coaxial pairs one towards each face of the ribbon, the pairs being arranged longitudinally along the path of movement of the ribbon and the ribbon of glass being continually advanced between pairs of opposed discs which engage and grind the two surfaces of the ribbon.

It has been found that with these known forms of tools, an accumulation of cullet is produced in the basin constituted by the central cavity in consequence of accidental breakages of the ribbon, which accumulation more or less obstructs the opening at the top of the hollow driving shaft through which the abrasive liquid is fed. The result is an irregularity in the feed of abrasive which is prejudicial to the quality of the grinding, and may cause stoppage of work for the removal of the fragments of glass.

The main object of the present invention is to devise a means of feeding the abrasive fluid to the lower grinding discs in apparatus of the kind referred to and to devise means of preventing cullet accumulation in the

(*Continued on page* 672)

Research Digest

Color and Light Scattering of Platinum in Some Lead Glasses

● IN THE FIRST PAPER in this series, Rindone and Rhoads reported on the colors of platinum, palladium, and rhodium, introduced as their chlorides, in alkali silicate, borate, and phosphate glasses. They found that platinum produced only gray colors in the borate and silicate glasses, whereas in the phosphate glasses yellow, orange, and brown colors as well as grays were observed.

The phosphate glasses were of particular interest because the equilibrium between metallic platinum (gray glasses) and ionic platinum (yellow and orange glasses) is shifted toward the formation of ionic platinum as the platinum chloride concentration increases.

In addition, in the concentration range 0.002 to 0.008 per cent by weight, platinum acts as a nucleating agent for the partial devitrification of the sodium metaphosphate glass. Palladium produces ionic yellow-to-brown colors in the silicate, borate, and phosphate glasses. Yellow and orange-to-amber colors as well as grays are produced in the silicate, borate, and phosphate glasses by rhodium.

Hampton, Turner and associates, and Sun and Silverman have also reported coloring of glasses by platinum. Of particular interest is the work of Hampton, who melted lead silicate glasses in both thoria and platinum crucibles. In the thoria crucibles he obtained colorless glasses, whereas in the platinum crucibles an appreciable yellow color was produced.

In the October, 1958, issue of the *Journal of the American Ceramic Society*, Ryder and Rindone report on the effects of lead oxide on the behavior of platinum in sodium silicate, borate and phosphate glasses.

As in the previous investigation, the platinum was introduced as a solution of $PtCl_4$. Lead oxide was added to the borate and silicate glasses as c.p. lead tetra oxide. In the phosphate glasses, lead metaphosphate of the highest purity obtainable was a convenient raw material for the introduction of lead oxide. As it was desired to maintain the molar ratio of $(Na_2O + PbO)$ to P_2O_5 at 1:1, the addition of lead oxide as lead metaphosphate eliminated the necessity of having to work with orthophosphoric acid.

The silicate and borate batches were melted in kyanite crucibles to yield 75 gm. of glass. The reactive phosphate glasses were melted in more dense mullite crucibles of a size to yield 50 gm. of glass.

Oxidation-reduction studies were made using the following materials: Cerium dioxide was introduced as cerium hydrate containing 77.38 per cent cerium dioxide and 1 per cent didymium oxide (by weight). Chemically pure sodium nitrate was substituted for sodium carbonate on a weight per cent basis (5 per cent of the total composition). Oxygen and chlorine gases of the cylinder-type reagent grade were either bubbled through the melts or used as a melting atmosphere. Arsenic was introduced as the c.p. trioxide.

After the test specimens had been annealed, the transmittances were measured in the range 400 to 740 $m\mu$ on a General Electric recording spectrophotometer.

The light scattering of the glasses was examined by passing a narrow beam of light through the specimens. The presence of submicroscopic particles of platinum in a glass that appeared to be clear under ordinary light could be detected by the appearance of a well-defined light path. (Tyndall effect).

In this investigation the most commonly observed form in which platinum was present in the glasses was the finely subdivided metallic state. In this form, the platinum was dispersed throughout the glass as submicroscopic colloidal particles. At low concentrations, these particles could be detected by light scattering (Tyndall effect), whereas at higher concentrations they caused the glasses to become gray.

Under proper oxidizing conditions, the platinum could be retained in the ionic state. In the borate and silicate glasses, strong oxidizing conditions were necessary to obtain ionic platinum, whereas in the phosphate glasses it was quite easy to obtain the ionic form. The ionic platinum gave yellow-to-orange colors.

This work has shown that in the sodium lead silicate and borate glasses, colloidal platinum can be detected by Tyndall scattering when introduced in quantities as low as 1 to 15 p.p.m. Increasing the lead content had no effect on these lower limits.

In the phosphate glass, increasing the lead content has no significant effect on the lowest concentration at which colloidal platinum can be detected. The presence of lead oxide, however, greatly increases the stability of ionic platinum in these glasses. For instance, in the previous investigation it was found that under normal melting conditions no more than 0.10 per cent platinum can be retained in the ionic form in the $Na_2O \cdot P_2O_5$ glass. The present investigation shows that as much as 0.8 per cent platinum can be retained in the ionic form when lead oxide is present.

In the sodium lead phosphate glasses, when the amount of platinum chloride introduced was large enough, the chlorine pressure resulting from the decomposition of $PtCl_4$ into $PtCl_2$ and Cl_2 was sufficient to prevent the platinum from being reduced to the metallic state. Below certain concentrations of $PtCl_4$ only colloidal platinum was obtained. It was observed that as the PbO content increased, the minimum platinum chloride concentration at which the transition from colloidal to ionic platinum occurred also increased.

It was shown that platinum could be retained in the ionic form in the silicates and borates if melted under strong oxidizing conditions. The difference in oxidizing power of the various oxidants can be understood if one considers the stage in melting during which the oxidizing agent is most effective.

CeO_2 oxidizes platinum in all glasses very effectively because of the manner in which it releases oxygen. CeO_2

has a slow rate of solution in these low-melting glasses. Its oxidizing action therefore begins in the early stages of melting and continues throughout the melting period by means of the reaction

$$2CeO_2 = Ce_2O_3 + 1/2O_2$$

which proceeds slowly.

The nitrate decomposition

$$2NaNO_3 \xrightarrow{380°C.} Na_2O + 2NO_2 + 1/2O_2$$

occurs mainly during the initial fusion of the batch, after which its oxidizing effect is very slight. Prolonging the melting period, or raising the melting temperature, diminishes the oxidizing effect of $NaNo_3$. On this basis it can be understood why $NaNO_3$ was more effective in oxidizing platinum in the borate glasses than in the higher-melting silicate glasses.

Oxygen, which was bubbled through the melt only after complete fusion of the batch had taken place, was less effective in oxidizing platinum in the borate and phosphate glasses than in the silicate glasses. This indicates that if the platinum became reduced in the early stages of melting it was quite difficult to reoxidize, except in the silicate glasses. The ease of reversibility of the equilibrium ionic platinum-metallic platinum toward ionic platinum in the silicate glasses was demonstrated by the fact that before bubbling oxygen through the melt, the glasses were gray, whereas after oxygen bubbling, the glasses were clear and yellow.

In those glasses where ionic platinum can be retained, about 0.01 per cent platinum must be present to give a noticeable color to glasses having a thickness of about 4 mm. In the reduced state, however, 0.001 per cent platinum gives a noticeable gray color. Hence, if platinum contamination is unavoidable, melting under oxidizing conditions will minimize the visible evidences of the contamination.

From the results of this study it was concluded that:

(1) Under the atmosphere of an electric furnace heated with silicon carbide heating elements, platinum introduced as platinum (ic) chloride gives colloidal gray glasses in sodium lead borates and silicates for all concentrations of PbO studied, whereas in the phosphate glasses, grays as well as yellow and yellow-orange ionic colors are produced.

(2) The addition of PbO to a sodium phosphate glass increases the stability of platinum ions. As much as 0.8 per cent ionic platinum has been retained in the lead glasses, whereas only 0.10 per cent can be retained in the lead-free sodium meta-phosphate glass.

(3) Under strong oxidizing conditions, ionic platinum colors can be obtained in the sodium lead borate and silicate glasses.

(4) The presence of at least 0.01 per cent platinum in the ionic state is required to give any of the glasses studied a noticeable yellow color. In the metallic colloidal state, approximately 0.001 per cent platinum is sufficient to cause the glass to become gray.

(5) Colloidal platinum in concentrations as low as 0.0001 per cent (1 p.p.m.) shows Tyndall scattering even though the glass may be clear and colorless under normal light.

George S. Huber

HUBER IN PEMCO SALES POST

George S. Huber, formerly vice president of sales, has been named manager of sales, ceramic and glass color division, of Pemco Corporation. This position has not been filled since the death of Jake Eagle last June. Mr. Huber has been with the company for six years, first as assistant.

CERAMIC SCHOLARSHIPS

Pennsylvania Glass Sand Merit Award Scholarships for 1958-59 have been awarded to eleven senior ceramic engineering students. Each man was selected by the awards committee of his school on the basis of scholastic achievement during the junior year and has received full scholarship assistance for his senior studies.

Recipients are Richard E. Mistler, Alfred University; Robert B. McLees, Clemson Agricultural College; James J. Hurst, Georgia Institute of Technology; Gerald K. Fehr, Iowa State College; Richard L. Wuske, Ohio State University; Leonard Cook, Pennsylvania State University; Donald S. Pasternak, Rutgers University; John F. Krumwiede, University of Texas; and Lawrence D. Johnson, University of Washington.

Since 1956, thirty-two students have received these Merit Award Scholarships, according to William J. Woods, Jr., vice president, who declared that students of this caliber are destined to become leaders throughout the ceramic industry.

HOMMEL RESEARCH CENTER

The O. Hommel Research Center was officially opened on November 18 in Carnegie, Pa. Located directly across from the offices and plant of the O. Hommel Company, the Center contains over 20,000 square feet. During the opening ceremony, Ernest M. Hommel, president, declared that it had been built because of the increasingly important role of ceramics in both old and new fields of technical endeavor.

The company has long been interested in research, having established the "Oscar Hommel Memorial Fellowship" for basic research in ceramic finishes at Mellon Institute in 1933.

New 20,000-sq.-ft. Hommel Research Center which was opened Nov. 18 by The O. Hommel Co. in Pittsburgh.

Current Statistical Position of Glass

Employment and payrolls: Employment in the glass industry during September, 1958, was as follows: *Flat Glass*: a preliminary figure of 28,100 given for September, 1958, indicates an increase of 6.4 per cent over the adjusted 26,400 reported for August, 1958. *Class and Glassware, Pressed and Blown*: an increase of 2.2 per cent is shown by the preliminary figure of 84,000 reported for September, 1958, when compared with the adjusted figure of 82,200 recorded for August, 1958. *Glass Products Made of Purchased Glass*: the preliminary figure of 13,700 given for September, 1958, indicates an increase of 4.6 per cent over the previous month's adjusted figure of 13,100.

Payrolls in the glass industry during September, 1958, were as follows: *Flat Glass*: an increase of 12.3 per cent is shown in the preliminary $15,699,386.26 given for September, 1958, when compared with August's adjusted $13,976,316.82. *Glass and Glassware, Pressed and Blown*: an increase of 1.9 per cent is shown in the preliminary $31,210,599.00 reported for September, 1958, when compared with the previous month's adjusted $30,620,158.42. *Glass Products Made of Purchased Glass*: a preliminary figure of $4,423,663.69 was reported for September, 1958. This is an increase of 2.3 per cent when compared with the adjusted figure of $4,325,483.96 for August, 1958.

Glass container production: production based on figures released by the Bureau of the Census, Industry Division, was 13,242,000 gross during October, 1958. This is an increase of 5.1 per cent over the previous month's production figure, 12,597,000 gross. During October, 1957, glass container production was 13,174,000 gross, or 0.5 per cent under the October, 1958, figure. At the end of the first ten months of 1958, glass container manufacturers have produced a preliminary total of 122,909,000 gross. This is 1.1 per cent below the 125,288,000 gross produced during the same period in 1957.

Shipments of glass containers during October, 1958, came to 12,995,000 gross, a decrease of 4.0 per cent from September, 1958, shipments which totaled 13,543,000 gross. Shipments during October, 1957, amounted to 12,806,000 gross, or 1.5 per cent under October, 1958. At the end of the first ten months of 1958, shipments have reached a preliminary total of 121,734,000 gross, which is 0.5 per cent above the 121,166,000 gross shipped during the same period of the previous year.

Stocks on hand at the end of October, 1958, came to 18,203,000 gross. This is 1.2 per cent over the 17,971,000 gross on hand at the end of September, 1958, and 4.1 per cent higher than the 17,471,000 gross on hand at the end of October, 1957.

GLASS CONTAINER SHIPMENTS

(All Figures in Gross)

Narrow Neck Containers

	October, 1958
Food	1,407,000
Medicinal and Health Supplies	1,681,000
Chemical, Household and Industrial	858,000
Toiletries and Cosmetics	960,000
Beverage, Returnable	556,000
Beverage, Non-Returnable	108,000
Beer, Returnable	50,000
Beer, Non-Returnable	636,000
Liquor	1,128,000
Wine	370,000
Sub-total (Narrow)	7,754,000

Wide Mouth Containers

Food	*3,830,000
Medicinal and Health Supplies	435,000
Chemical, Household and Industrial	194,000
Toiletries and Cosmetics	254,000
Packers' Tumblers	37,000
Dairy Products	176,000
Sub-total (Wide)	*4,926,000
Total Domestic	12,680,000
Export Shipments	315,000
TOTAL SHIPMENTS	*12,995,000

* This figure includes Fruit Jars and Jelly Glasses.

GLASS CONTAINER PRODUCTION AND INVENTORY

(All Figures in Gross)

		Production Oct., 1958	Stocks Oct., 1958
Food, Medicinal and Health Supplies; Chemical, Household and Industrial; Toiletries and Cosmetics	Narrow Neck	4,972,000	6,577,000
	Wide Mouth	*4,979,000	*5,824,000
Beverage, Returnable		593,000	1,792,000
Beverage, Non-Returnable		91,000	227,000
Beer, Returnable		170,000	447,000
Beer, Non-Returnable		669,000	904,000
Liquor		1,123,000	1,463,000
Wine		423,000	618,000
Packers' Tumblers		42,000	123,000
Dairy Products		180,000	228,000
TOTAL		*13,242,000	*18,203,000

* This figure includes Fruit Jars and Jelly Glasses.

PENNA. CERAMICS ASS'N. OFFICERS

J. Earle Duncan, Pittsburgh Glass Company, and Fred W. Schroeder, North American Refractories Company Research Center, have been elected to the board of directors of the Pennsylvania Ceramics Association. They are replacing Joseph S. Gregorius and Robert A. Moffett, respectively, who resigned.

Officers for 1959 are E. M. Hommel, the O. Hommel Company, president; J. D. Clark, Foote Mineral Company, first vice president; G. W. Reuning, Mexico Refractories Company, second vice president; J. K. Martin, Posey Iron Works, managing director, and R. G. Ehman, Pennsylvania State University, secretary-treasurer.

Left to right, Dr. Jesse T. Littleton, Dr. Eugene C. Sullivan, and the late Dr. William C. Taylor, cutting cakes at dinner in their honor. Each man received a glass replica representing his early contribution to Corning's research program.

NEW COLUMBIA-SOUTHERN PLANT

Columbia-Southern Chemical Corporation has a new soda ash and sodium sesquicarbonate plant in partial production at Bartlett, California. The company developed an entirely new purification process for soda ash, which has been installed in the new plant.

Joseph A. Neubauer, Columbia-Southern president, has announced that the soda ash capacity at this Bartlett operation is three times as great as that of the original plant which is being dismantled.

GYPSUM IN GLASS

Fay V. Tooley, professor of Glass Technology at the University of Illinois; R. W. Hopkins, president, Glass Technicians, Inc.; and Robert Hamilton of United States Gypsum Company, have co-authored a booklet entitled, "Gypsum in Glass," a compilation of the latest information on the functions of the sulfates and particularly calcium sulfate in the glass batch.

Copies are available without charge from the United States Gypsum Company, 300 W. Adams St., Chicago 6, Ill.

Glass and ceramics section, National Safety Council, officers for 1958-59, left to right: John Skendall, safety director, Harbison-Walker Refractories, 1st vice chairman; J. E. Croushore, National Safety Council; Clyde C. Ruddick, manager, safety, health and plant protection, Pittsburgh Plate Glass Co., chairman; E. L. Wray, safety director, Ball Brothers Glass Co., 2nd vice chairman; and A. H. Burkett, safety supervisor, Owens Illinois Glass Co., secretary.

HONORED BY CORNING GLASS

Dr. Eugene C. Sullivan, the late Dr. William C. Taylor who died at his home in Corning, N. Y., five days later on November 2, and Dr. Jesse T. Littleton, pioneers of glass research, were honored at a dinner on October 28 at the Corning Glass Center. Eighty-five fellow research scientists and engineers joined in the tribute during an informal program commemorating the 50th anniversary of Corning's research laboratories.

Each guest of honor received a cake topped by a glass replica representing his early contribution to the research program. Dr. Sullivan was given a miniature lantern globe; Dr. Taylor, a chemical flask; and Dr. Littleton, a battery jar.

Amory Houghton Jr., staff vice president, who acted as master of ceremonies, presented hand-lettered parchment scrolls, signed by every one present, to the three honor guests. The inscription read, "In commemoration of the 50th anniversary of the Corning Glass Works Research Laboratories, and in sincere tribute to research, we proudly sign our names below."

Special guests at the dinner were Amory Houghton, United States Ambassador to France who is on leave as chairman of the board for Corning Glass Works; William C. Decker, company president; Dr. William H. Armistead, vice president and director of research and development; Arthur T. Weber, vice president and director of engineering and manufacturing; and Dr. Charles F. De Voe, director of ceramic research.

CERAMIC ENGINEERING AWARD

The National Institute of Ceramic Engineers has established an annual award to "Honor the nation's outstanding young ceramic engineer," according to Wayne Deringer, president. Each year one man will receive an award in honor of his Professional Achievement in Ceramic Engineering.

The first such honor, the 1958 Pace Award, will be presented at the next annual meeting of the National Institute of Ceramic Engineers in Chicago on May 17, 1959.

One or more nominations for the annual Award may be made by any individual or group. Further details may be obtained from the PACE Award Committee, The National Institute of Ceramics Engineers, 4055 North High Street, Columbus 14, Ohio.

NAT. SAFETY COUNCIL ELECTIONS

Clyde C. Ruddick, manager of safety, health and plant protection, Pittsburgh Plate Glass Company, has been elected chairman of the glass and ceramic section, the National Safety Council, for 1958-59. He has been associated with Pittsburgh Plate since 1951 and has had more than 30 years of experience in various capacities in the industrial safety field.

Other officers are John Skendall, safety director of Harbison-Walker Refractories, 1st vice chairman; E. L. Wray, safety director, Ball Brothers Glass Co., 2nd vice chairman; and A. H. Burkett, safety supervisor, Owens-Illinois Glass Co., secretary.

Mr. Ruddick has also been chairman of the Western Pennsylvania Chapter of the American Society of Safety Engineers.

New Equipment and Supplies

AIR VIBRATOR

National Air Vibrator Co., 2372 West 7th St., Cleveland 13, Ohio, has developed a new "Hi-Impact" vibrator for electrostatic precipitators and dust collectors. There are no body assembly bolts to shear or stretch, according to the manufacturer, and the piston is the only moving part.

ELECTRIC MOTOR DESIGN

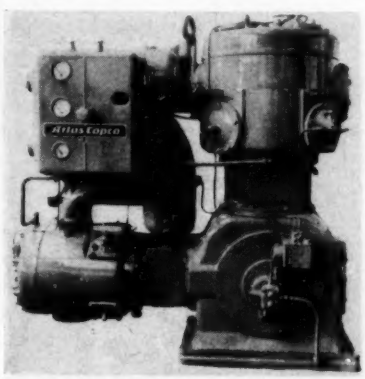
The Electric Motor division of A. O. Smith Corporation, Tipp City, Ohio, has announced a new design concept in electric motors featuring complete sealed protection for their starting switches. Major feature is complete containment of the switch, capacitor, thermostat, and terminal board, making these parts completely impervious to dirt, dust, oily accumulations, and processing materials fines.

HIGH CAPACITY NOZZLES

Bete Fog Nozzle, Inc., Greenfield, Mass., has designed a new series of high-capacity nozzles which are said to give finer break-up and are non-clogging. They employ three separate orifices from each of which a jet impinges on a deflector plate; the jets are broken up and intermingled to form a full-cone spray.

AIR COMPRESSOR

Atlas Copco, 610 Industrial Ave., Paramus, N. J., has announced a new intermediate size stationary air compressor which delivers up to 835 cubic feet of air per minute at 100 psi.



LONGER LIFE FOR GLASS MOLDS

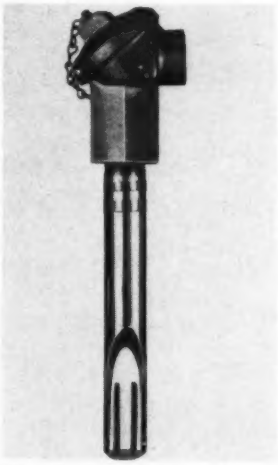
Todco, P. O. Box 229, Whittier, Calif., has a new process for prolonging the life of glass molds. The cast iron mold halves are coated with a paint-like nickel composition which, when heated to 1650°F in a reducing atmosphere, is reduced to nickel plate. Heat processing of the molds may be done by a local heat treater.

The plate permeates the surface to form a hard, abrasion-resistant case on the casting. With all of the nickel absorbed into the casting, there is no build-up or increase of the surface dimensions of the mold; no additional machining is required after plating.

This process, states the company, increases the resistance of the glass molds to abrasion and prevents edge breakdown.

THERMOCOUPLE

E. C. Smith Manufacturing Company, Forrest & Hector Sts., Conshohocken, Pa., has a new heavy-duty thermocouple called "PermaKouple." It consists of a heavy protecting tube containing two #8 B&S gage wires completely embedded in solid ceramic. The tightly packed ceramic insulation prevents corrosion or scaling of the wires, according to the company, and eliminates the danger of flash fires in the event of a burn-through.



CONTROL INSTRUMENTS

Powers Regulator Company, 3434 Oakton St., Skokie, Ill., has announced a new series of "thin-line" temperature and pressure controllers.

They are used with diaphragm-operated valves for gradual, accurate regulation of temperature or pressure, states the company. Changes in the process under control are sensed by a remote nitrogen-filled bulb connected by a capillary to the controller. These changes are relayed by the controller to the valve, which modulates the heating, cooling, or pressure medium to keep the process at the desired point.

PRESSURE SWITCH

Meriam Instrument Co., 10812 Madison Ave., Cleveland 2, Ohio, has developed a precision pressure switch consisting of a contactor manometer and a relay power-supply package. The unit may be used for alarm signalling as well as for control in applications involving pressure, vacuum, differential pressure, flow and liquid level.

COMPRESSOR SYSTEM

Ingersoll-Rand, 11 Broadway, New York 4, has developed an automatic compressor control system called "Tendamatic" which continuously supervises and checks compressor operation and gives warnings if malfunction occurs. It is said to check air pressures and temperatures, lubricating oil pressure and temperature, and cylinder lubricator operation.

SPECTROGRAPH

The Instruments Division, Philips Electronics, Inc., 750 South Fulton Ave., Mount Vernon, N. Y., has announced a new spectrograph which, the company declares, operates at twice the potential formerly available and incorporates many design improvements for the rapid qualitative and quantitative analysis for elements in liquids, powders and solids. The instrument covers a range of 87 elements in the atomic scale.

BRAZED WIRE CLOTH

The Cambridge Wire Cloth Company, Cambridge, Maryland, is producing industrial wire cloth that is brazed after weaving in order to prevent shifting of the wires in installations where the material is subjected to severe vibration.

CATALOGS RECEIVED

Westinghouse Electric Corporation, Box 2278, Pittsburgh, Pa., has a 27-page brochure on "Synchronous Motors and Controls," which contains motor selector charts, application data, and formulas for calculating power factor.

Botfield Refractories Company, Schaff Building, Philadelphia 2, Pa., has three new refractories bulletins which illustrate and describe, respectively, fire brick cement, plastic fire brick, and castables.

Lewis-Shepard Products, Inc., 125 Walnut St., Watertown 72, Mass., has published the Fall issue of the Lewis-Shepard Lever, a 16-page magazine devoted to materials handling which includes an article on the science of hydraulics as applied to fork lift trucks.

Fisher Scientific Company, 717 Forbes St., Pittsburgh 19, Pa., has a comprehensive bulletin on high-speed, direct-reading single-pan balances, ranging from a micro analytical balance with an accuracy of 0.002 milligram to a giant heavy-duty balance for remote-control weighings.

Selas Corporation of America, Dresher, Pa., has a 4-page bulletin describing the Selas Propane Diluter which accurately mixes propane or butane with air to supply stand-by fuel and maintain heating, heat processing and refrigerating operations when regular gas supplies are temporarily curtailed. The diluter is said to produce the same heating rates as are normally attained, and to maintain constant pressures even when load variation is extreme.

L & L Manufacturing Company, 316 Eighth St., Upland 32, Del. Co., Pa., is distributing a leaflet describing various heating, treating, processing, production and laboratory furnaces and two series of forced convection ovens.

Leeds & Northrup Co., 4934 Stenton Ave., Philadelphia 44, Pa., has issued a data sheet giving complete information about the Model S Speedomax G multiple-point recorder controller assembly for two-position control. The assembly can be used for measurement and control of 6, 8, 12, 16, 20 or 24 thermocouple points.

BOOK REVIEW

Glass-Melting Tank Furnaces, by Dr. Ing. R. Günther. Translated from the German by John Currie with a foreword by Emeritus Professor W. E. S. Turner. Published July 15, 1958, by the Society of Glass Technology, Thornton, Hallam Gate Road, Sheffield 10, England.

This book contains a comprehensive treatment of the construction and operation of glass-melting furnaces. It is limited, however, to tank furnaces heated by combustion. Neither pot furnaces nor electric heating are considered. Although based chiefly on the German glass manufacturing practice, much information on developments in American and British glass tanks is included. The emphasis is entirely on the melting of glass, with practically no attention to delivery and conditioning.

After an introductory chapter, types of furnaces are discussed on the basis of both glass-containing structures and firing systems.

The third chapter deals with essential elements in the operation of glass-melting tank furnaces, namely: charging and melting of the glass, temperature distribution and heat transfer, currents in the glass, and the furnace atmosphere.

In the fourth chapter, after brief consideration of the layout of the factory building and the effect of block selection on tank life, construction details of the tank basin, the superstructure, the ports and the steel work are discussed.

Subsequent chapters are devoted to heat recovery by regeneration and recuperation; gas and air valves; and control equipment, including measuring instruments and automatic control systems. A brief chapter on the heating up and letting out of a glass furnace is included.

Chapters nine and ten are devoted to furnace capacity, fuel efficiency, and fundamental thermal calculations. Under the latter heading are treated the combustion process itself, the flow of gases in the furnace system, heat transfer, heat recovery, and heat balance. A final brief section is devoted to the possibility of designing a glass-melting furnace based on calculation.

The last chapter of the book, specially written by Günther Stein, is a history of the early development of tank furnaces with a detailed account of the contributions of the Siemens brothers. Appendices contain valuable technical data for thermal calculations, 24 pages, and a bibliography of general reviews and books on glass furnaces.

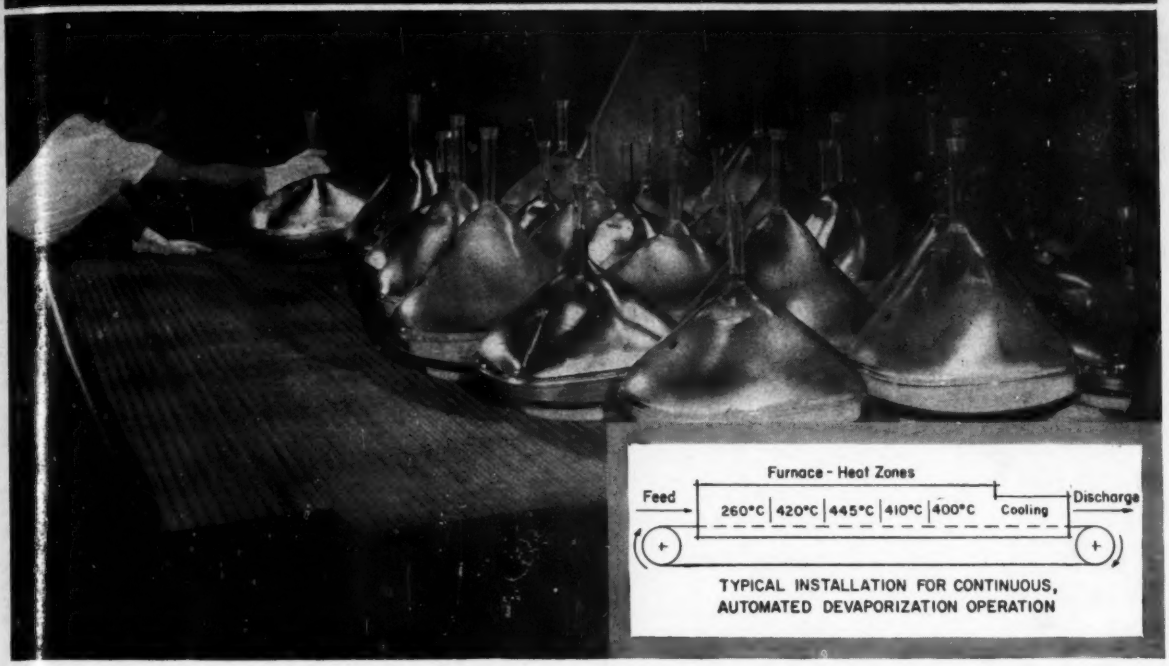
In translating Dr. Günther's authoritative text from the German, Mr. John Currie performed a great service for English and American glass technologists, not only through the change in language but also through conversion from metric to British units. Only a few modifications and additions were made by the author and the translator to bring the book up to date. There has been, however, rearrangement of material in the text and a regrouping as to chapter headings with a considerable increase in the number of references, particularly to modern works in the United States and Great Britain.

SCIENTIFIC TRANSLATIONS

The Custom Translations Club has been established by Consultants Custom Translations, Inc., New York City to furnish scientists in all fields with translations from Russian, Czechoslovakian and Polish.

Further details may be obtained from Steven H. Smith, manager, at 227 West 17th Street, New York 11.

Cambridge WOVEN WIRE BELTS



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Container Glass Compositions

(*Continued from page* 641)

Thermal Expansion. The coefficient of thermal expansion, Fig. 12, has a spread of nearly 14 X 10^{-7} with the peak area of the distribution curve being in the 86-to-92 X 10^{-7} region.

Softness Temperature, Annealing Point and Strain Point. These three low-temperature viscosity measurements are given in Figs. 13, 14 and 15. The glasses in use for the automatic production of glass containers are thus shown to possess a very wide range of temperatures

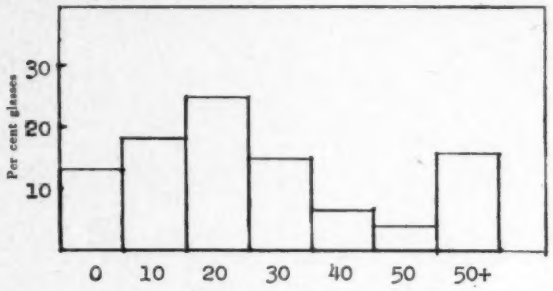

Fig. 20. Seeds and blisters per ounce.

for equivalent low temperature viscosities. In the case of the softness temperature the range is 40°C, the range in the case of the annealing point is 55°C while for the strain point the range is 53°C.

Working Characteristics Indicies. Formulas reported by A. K. Lyle[7] have been used very successfully over the past several years as a means of determining the comparative working characteristics of glasses from low-temperature viscosity data.

Figs. 16, 17, and 18 show by distribution curves the Working Range Index, Relative Machine Speed and "Gob Temperature" in °C, respectively, of the glasses examined during the 1957 period.

The Working Range Index shows a range from 165 to 193 with two peaks, one at 175 and the other at 183.

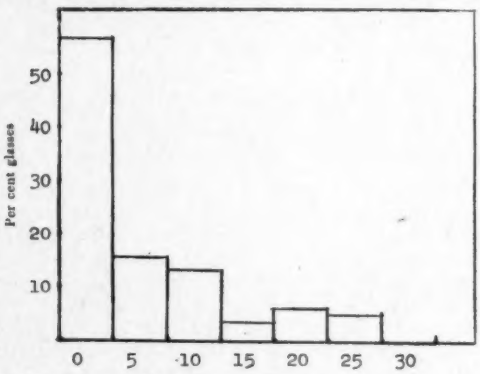

Fig. 21. Blisters per ounce.

These two peaks again indicate the two general families of glass compositions.

The Relative Machine Speed ranges from a value of 95 to 115 per cent with the peak being near 105 per cent.

The "Gob Temperature" has a spread of nearly 100°C with the peak value being near 1210°C.

The Glass Quality measurements of the 1957 glasses are given in figs. 19, 20 and 21 which illustrate the distribution of the values for homogeneity, seeds per ounce, and blisters per ounce. The peak at grade B, shows that the great majority of the glasses produced were of very good homogeneity.

Seediness, in practice, is usually determined by customer requirements and sometimes by furnace limitations. In this survey there are almost as many seedy as seed-free glasses. The general level of seediness being 20 seeds per ounce.

Blisters, which by definition, are relatively large bubbles and which are considered as originating in some secondary reaction between the melting glass and furnace atmosphere, or refractories, are generally absent. A blister count of more than five per ounce is usually indicative of an abnormal condition somewhere in the nose of the furnace or in the feeders.

TABLE V

Geographical Comparison of 1957 Flint Container Glasses

Average Chemical Composition

	Area I Per cent	*Area II* Per cent	*Area III* Per cent
Silica, SiO_2	71.8	72.4	71.0
Iron plus Aluminum oxides, R_2O_3	1.7	1.7	2.6
Calcia, CaO	8.0	9.9	10.6
Magnesia, MgO	3.2	0.6	—
Barium oxide, BaO	0.4	0.4	0.1
Sodium oxide, Na_2O	14.2	13.9	14.1
Potassium oxide, K_2O	0.4	0.7	1.4
Boric oxide, B_2O_3	—	—	0.15
Sulfate as SO_3	0.2	0.2	0.15
Fluorine, F_2	0.2	0.2	0.05
Iron oxide, Fe_2O_3	0.058	0.062	0.055

TABLE VI

Geographical Comparison of 1957 Flint Container Glasses

Average Values of Physical Properties

	Area I	*Area II*	*Area III*
Density, g/cc. at 20°C	2.493	2.492	2.507
Coefficient of Thermal Expansion 0-300°C, X10^{-7}	87.6	89.1	91.5
Softness Temperature (log viscosity = 7.65)	713°C	715°C	717°C
Annealing Point (log viscosity = 13.0)	533°C	539°C	544°C
Strain Point (log viscosity = 14.5)	492°C	499°C	507°C
Gob Temperatures (log viscosity = 3.0)	1217°C	1208°C	1196°C
Working Range Index	180	176	171
Relative Machine Speed, per cent	102	105	108

Geographical Comparison of the 1957 Flint Container Glasses

The flint container glasses surveyed during 1957 were sufficient in number to allow a comparison between geographic areas. For this purpose the United States was arbitrarily divided into three regions, the Northeast, the South and the West Coast, as shown in Fig. 22. The averages of chemical compositions and the averages of physical properties for each of these areas are given in Tables V and VI.

(*Continued on page* 662)

SALES APPEAL OF CLEAR CERIUM GLASS

Flint glass with cerium has market potential in the container field because of its ultraviolet absorbing properties

a report by LINDSAY

Smart merchandisers of consumer goods know the sales appeal of attractive display of products in *clear glass containers.*

Brightly colored pharmaceutical pills and capsules. Beer. Vegetable oil products Bleaching solutions. These and many other products are often packed in amber or dull brown bottles for protection against light.

How much more appealing to the buyer if they were packed in sparkling, clear glass! Cerium glass which can be colorless in visible light gives protection from ultraviolet light. Here's a big market potential for you.

GLASSES MADE WITH CERIUM OXIDE AND COBALT OR VANADIUM OXIDES

Nearly colorless glasses showing ultraviolet absorption may be made with cerium oxide in combination with cobalt or vanadium oxides. Vanadium tends to impart a green yellow color to the glass, but cobalt and cerium oxides produce glasses which are nearly colorless or have a very light blue color. Suitable ultraviolet absorbing glasses contain 1.9-6.5% CeO_2 with 0.5-2% V_2O_5, and 2-3% CeO_2 with 0.01-0.02% Co_2O_3. With cerium contents as low as a few tenths of a percent, the ultraviolet absorption may still be enough to make useful containers.

Cerium is usually added to the glass batch as cerium hydrate. However, for low-cost application, the cerium should be added in its cheapest form. Rare earth sodium sulfate is the most economical source of 21% CeO_2 for use as the glass additive.

The composition of rare earth sodium sulfate is $RE_2(SO_4)_3.Na_2SO_4.2H_2O$. It is a light pink crystalline powder, sparingly soluble in water and acids. In normal manufacture, it is dried and some of the water of hydration (combined water) is removed. The pink color is due to the rare earth neodymium.

Rare earth sodium sulfate is obtained from the chemical processing of cerium ores such as monazite. Therefore, it is the cheapest source of cerium where the other rare earths do not interfere in its use. For ultraviolet absorbing glass use, these other rare earths do not interfere and may actually serve a useful purpose as physical decolorizers.

We will be happy to send you a free copy of our bulletin "Cerium in Ultraviolet Absorbing Glass Containers."

Lindsay produces cerium and other rare earth oxides in a variety of purities for many ceramic applications. These

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(*Continued from page* 660)

Chemically, several interesting differences are present. They are explained by the choice of raw materials located within economical shipping distances of the glass-factory.

In Area I (Northeast), 77 per cent of the glasses are made with dolomite as the chief source of alkali earth oxides (CaO and MgO).

In Area II (South) only 12.5 per cent of the glasses contain appreciable quantities of magnesia (MgO), while in Area III (West Coast), all the glasses are made with calcite lime and show little or no magnesia (MgO).

The higher alumina content of the glasses made in Area III (West Coast) is due to the use of feldspathic sands as the source of silica, the alumina being established by its proportion in the sand.

The higher potash values also are due to the use of these sands.

The presence of B_2O_3 in most of the Area III glasses results from the use of soda ash containing a small percentage of borax.

The chemical differences among the three areas are great enough to result in three significantly different average compositions. As shown in Table VI, differences among values for physical properties also exist. The coefficient of expansion is the least for Area I (Northeast)

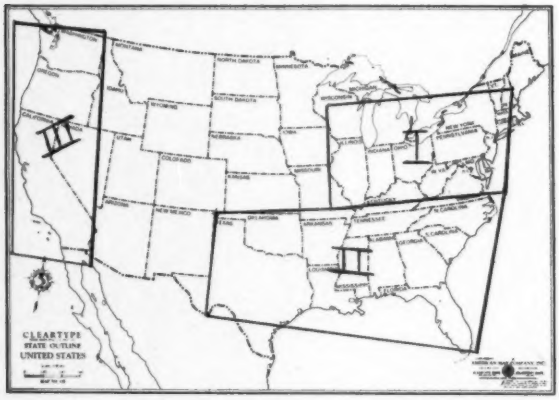

Fig. 22. Container manufacturing areas on a geographical basis.

and greatest for Area III (West Coast). The temperatures for selected viscosities increase in the order Area I, Area II and Area III. The "Gob Temperature" and Working Range Index show a decrease in going from Area I to Area III while the Relative Machine Speed increases in the same order.

These differences in physical properties and working characteristics which result from minor differences in chemical composition serve to illustrate the now well-known fact that a batch formula stated in pounds of sand, soda ash, feldspar, lime, etc., is of little value unless it is related to a definite chemical composition representing values for physical properties and calculated working characteristics. The standard chemical composition so formulated must then be kept within specified control limits if the desired values of physical properties are to be maintained with the control limits necessary for successful modern glass-forming operations.

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ACS West Coast Meeting

(*Continued from page* 648)

Instrumentation

A paper by Minneapolis-Honeywell, entitled "Trends in Instrumentation," reviewed new applications to glass manufacture, and pointed out the fact that many instruments now have longer life than formerly, and maintenance cost is lower.

Applications reviewed included automatic computers, which are widely used in statistical control, furnace pressure controls with an increased speed of response, new automatic controls for the automatic rationing of air to fuel, more sensitive glass level control equipments, and new radiation units for measuring temperatures of molten glass.

Management Training

"The Psychologist Looks at Management Training" was a general interest subject presented by Dr. William A. Thomson, who pointed out that managers must be specialists in human engineering. Human factors, rather than technical factors, he said, are the most important. Managements must recognize that most engineers and scientists must be handled differently than some other groups, in order to derive the most value from them.

The manager should apply himself to the development and to the growth of individuals, and should not hesitate to use professional counsel from outside his organization. He must think in intangibles. He must have a potential for progressive change and improvements.

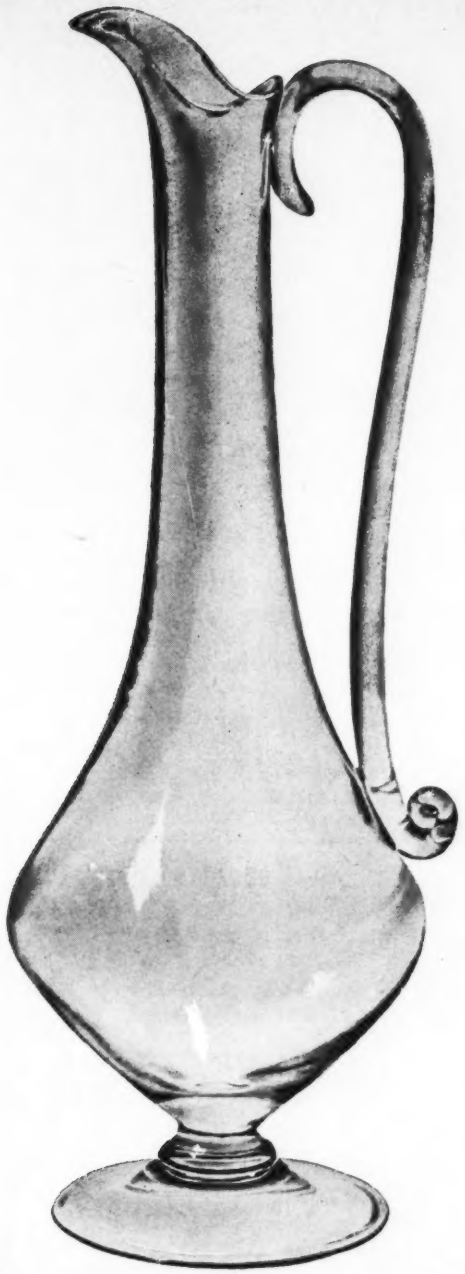
Highlights of Scientific Glass Blowing

(*Continued from page* 646)

ing attachment ideal for experimental work. A paddle-forming method suitable for job-lot production work is shown in Fig. 7. In this application of template paddle forming, an air cylinder, having vertical and horizontal screw adjustments, supports the template. This device simplifies blowing bulbs for volumetric apparatus which normally are precalibrated (prepointed) and reshaped to size. Both methods require a fast-moving lathe; the softened glass expands to the template by centrifugal force, aided with light puffs of air. A large soft flame, held at a small angle to the work, heats the glass during the forming operation. Glass "foldover" is prevented by rounding the sharp leading edge of the template paddle. Glass to template contact is indicated by fine circumferential lines.

The electronic tube industry came into being with the

(*Continued on page* 664)



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(*Continued from page* 662)

invention of De Forest's radio tube in 1906. In order to construct the more than 40,000 different tube types developed in the last 50 years, innumerable new methods had to be devised. A phase of these developments, of particular interest to scientific glass blowing, is sealing glass to metal.

Tubular glass-copper seals were invented by Housekeeper in 1923. His method, of feather edging the copper, allowed almost any glass to be fused to thin malleable metals that would withstand sealing temperatures. The need for stronger tubular seals and heavier lead-in wires resulted in extensive metallurgical research during the 1930's.

From these developments came Kovar, an alloy of nickel, cobalt and iron, an important glass-sealing metal for the scientific glass blower. Several soft glass sealing alloys also were developed; their properties and sealing conditions are given by Partridge[12], Monack[13] and Kohl[14].

Frequently, the glass-sealing alloys aid in the formation of difficult openings, when constructing scientific apparatus. Precision shapes, which are round, square or rectangular, are formed in glass tube walls by first beading the unoxidized metal model with glass, then sealing this bead into a rough-sized opening. After annealing, the completed seal is immersed in acid (such as Aqua Regia) and left in a hood until the metal is completely dissolved.

Illuminated advertising displays of glass tubing were shown in 1904, but the industry grew only after Claude introduced the neon sign in 1910. A number of firms were licensed to use Claude's patents; after the patents expired in 1932, sign shops appeared in cities across the country. With "lights out" during World War II many of the specialized glass-blowers entered the electronic tube field. After the war, electrodeless signs appeared with individual letters illuminated by an R.F. field. Due to radio interference, manufacture of these signs soon stopped. Today, neon sign making is an established industry; however, some of the large volume work has been affected by vacuum-formed plastic signs.

Optical Industry

In 460 B.C., Demicritus, viewing the night sky through his lens, announced that the milky way was made up of many stars. From this early start came great inventions; spectacles, in 1317; the microscope, in 1590; and the telescope, in 1609. Progress in optical working contributed toward improving methods of cutting, drilling, grinding and polishing glass for scientific glass working, In the manufacture of ground joints and stopcocks, grinding is accomplished on a single-head lathe. (Fig. 3). Another machine, for grinding and polishing apparatus, uses wet abrasive belts (Fig. 9).

Diamonds were used for cutting glass in France as early as 1500. The optical industry recognized diamond tools as a means for producing a faster and better job. Continued improvements, for securing the diamond particles, resulted in metal-bonded diamond drills and cut-off wheels now used by apparatus workers.

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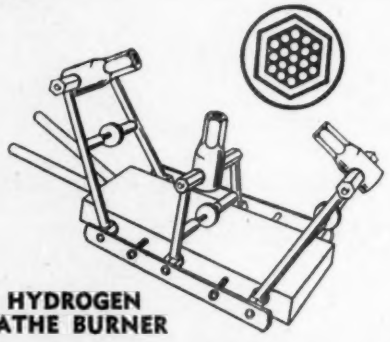

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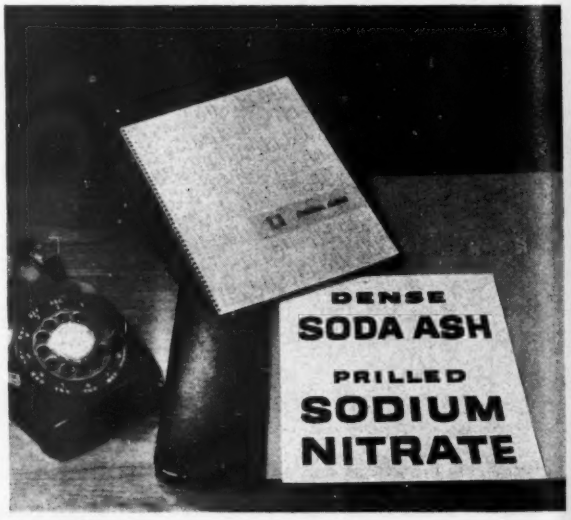

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Fused Quartz

It has often been said that fused quartz (or silica glass) would be the ideal glass for scientific apparatus, were it not for fabricating difficulties. A few desirable properties are thermal shock resistance, high softening temperatures and exceptional purity.

Quartz was fused and made into shot and fibers in 1839 by a Frenchman named Goudin. Thirty years later fused quartz tubing was made by Gautier of Germany. By 1900, tubing was produced in England and formed into useful apparatus. Since then, much effort has been applied toward improving the quality and lowering the cost of transparent tubing. The search for simplified fabricating techniques, to overcome the limited working range of fused silica, has resulted in a number of contributions to scientific glassblowers. Large-diameter fused quartz work, for example, is simplified with improved burners (Fig. 10).

These quiet burners have a hot core-flame of hydrogen and oxygen for softening the glass; a lower-temperature outer sheath-flame of hydrogen prevents the sublimation of silica near the section being worked. On the other extreme, thin-wall, small-diameter precision work is accomplished by vacuum forming (Fig. 11). Evacuating the air lowers the temperature required to work fused silica. In this application, a two piece carbon mandrel allowed the center ground joint to be made during the vacuum forming of the tube. The inner glass tube was then sealed by conventional methods. The solid plug and handle, shown near the fused quartz oven, also was vacuum formed. Two parallel holes, seven thousandths of an inch in diameter, were made in the plug by fusing in tungsten wires during the glass shrinking operation. After cutting the plug to size, the wires were removed by electrolytic etching.

Fig. 11. Vacuum-forming, micro fused quartz apparatus overcomes working difficulties. Duplicates are identical (size compared with book match).

Thermometers and Engraving

The thermometer was invented in 1592, by Galileo Galilei. By the middle of the 17th century, scientists of this period made many improvements in thermometers as well as barometers and hydrometers. Some of the

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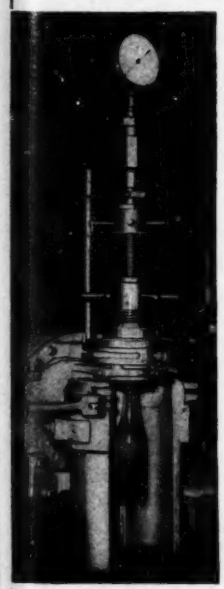

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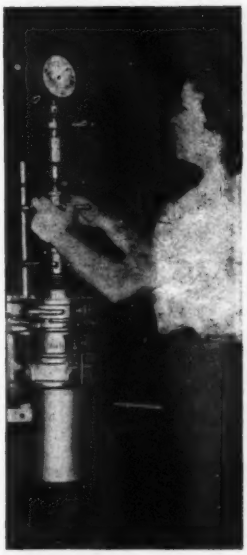

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first thermometers were three feet long and hermetically sealed by heating with the enameler's torch, while twisting the glass until closed[15].

The scaled divisions, made by fusing glass beads to the thermometer stem, were established by the coldest day as the low point and the melting of butter as the upper point. Wax engraving was practiced after Schiele found hydrofluric acid would attack glass in 1771. Improvements in calibrating methods may be jointly attributed to thermometers and the Babcock milk testing apparatus.

Three centuries of interest in thermometers resulted in thousands of variations of glass temperature indicators. Manufacture has remained a highly specialized field because of special skills, equipment and large assortments of expensive tubing.

Engraving, aside from thermometer making, presents a problem to the scientific glassblower not equipped with machines. Attempts to overcome this limitation has led to using precision bore tubing with fired on glazes or decals. In laboratory glass shops, the needle for cutting the beeswax is mounted in a jig, fixed to the tailstock or burner carriage of a glass-blowing lathe and operated manually.

A more frequent practice, when the engraved section is not in the area to be used, is to use standard calibrated items from stock. Most manufacturers of this ware will take special engraving work.

Future Trends

Present conditions indicate that scientific glass blowing will become a more exacting art. This is coming about through greater use of glass as an engineering material, glass in combination with other materials

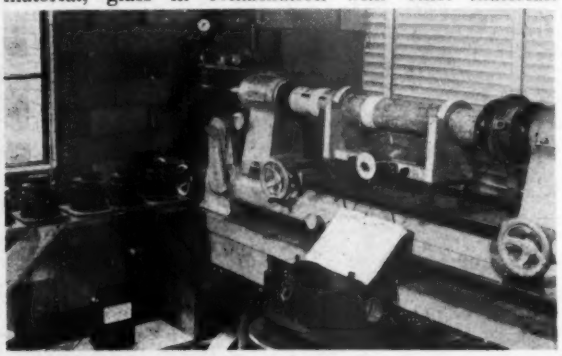

Fig. 12. Precision temperature-controlled oven, mounted on standard glass lathe, used for vacuum-forming an experimental microwave tube.

having precision dimensions, and continued efforts toward miniaturization. An important factor for producing close tolerance glass apparatus competitively is to replace costly trial-and-error methods by efficient techniques.

Vacuum Forming

Earlier in this article paddle forming was described for producing accurate outside diameters. Another useful technique is vacuum forming[16], for control of inside diameters. Improvements in vacuum forming are finding solutions to many modern problems. The "shrinking"

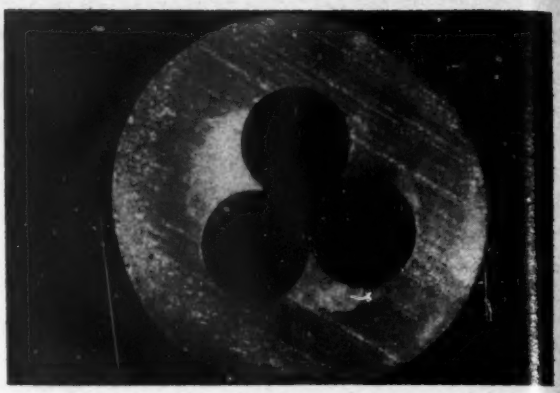

Fig. 13. Cross section of pattern produced inside glass tube after removing metal mandrel (cover picture illustrates operation).

process was selected by Sandor[17] when a metal helix had to be secured within a glass tube so that only 1 percent of the area of each turn of wire was contacted by glass. This was accomplished with an electric oven (Fig. 12) wound with resistance wire in sections. The temperature in each section is regulated with a rheostat and controlled with a thermocouple. Thermal variations of less than 5°C over the oven length was maintained.

Open flames are also suitable for vacuum forming glass over precision metal mandrels (Fig. 14). Mandrels are usually made by one of three methods, centerless grinding, die drawn, or by milling machines. These methods can maintain tolerances better than 0.001" required for many precision jobs (Fig. 13a).

Precision bore tubing is a standard part of some scientific apparatus, and numerous new uses are in sight. Precision bore burettes and monometer tubes required in large quantities are formed by production methods. Oven forming (Fig. 14) is one method. A group of evacuated test tubes containing mandrels are shrunk by dipping into an oven held at about 700°C.

Glass - Plastics

After World War II, there were some rumors that plastics might replace glassware. (The author confesses that his concern led to the construction of steam and hot

(*Continued on page* 668)

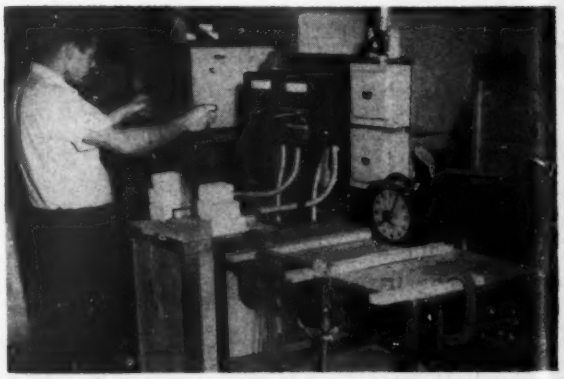

Fig. 14. Quantities of precision ore tubing, required for volumetric apparatus, are oven formed by careful control of time and temperature.

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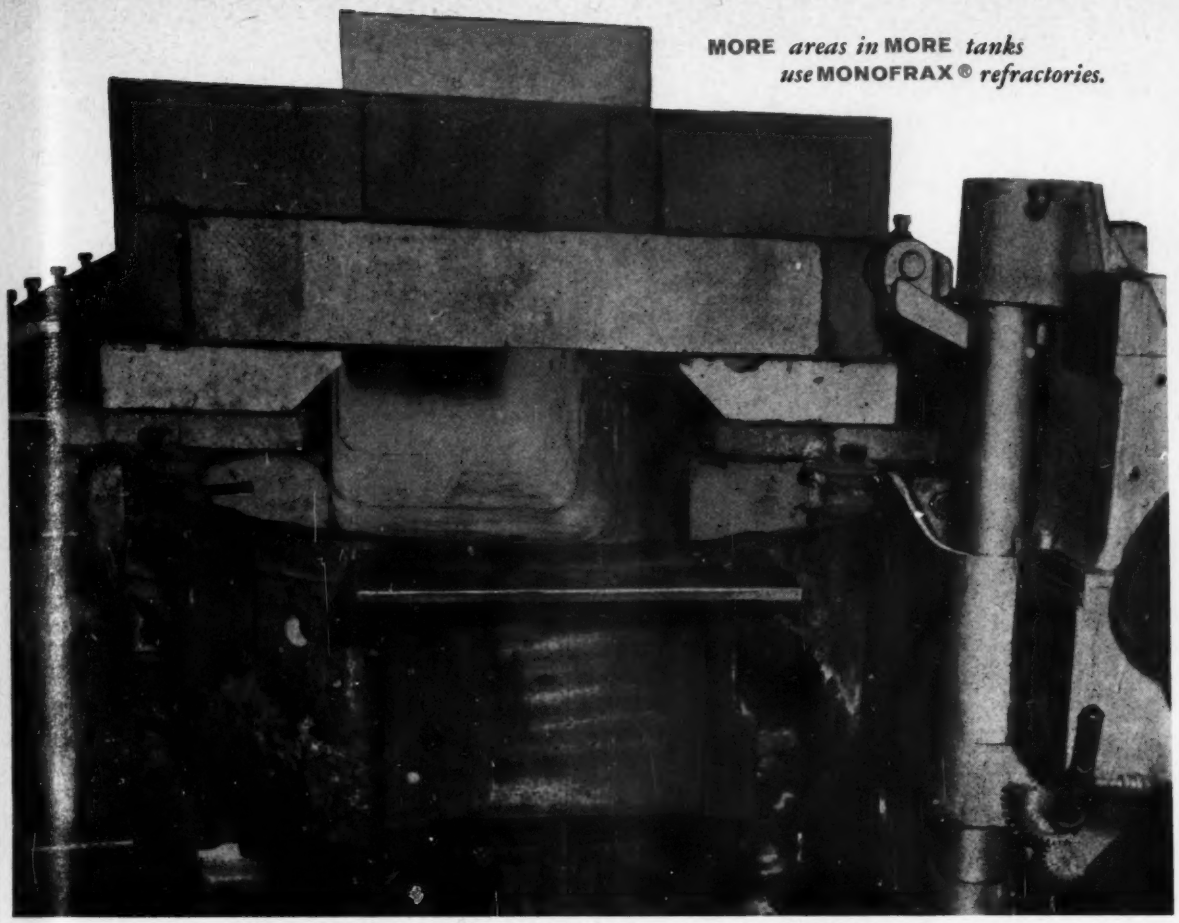

FEEDER CHANNEL is one of four in this tank that are lined with MONOFRAX M refractory. It was chosen because it is highly resistant to erosion and avoids refractory contaminates. Tank is end fired and melts clear, soda-lime glass.

This feeder channel typifies special-purpose areas that need a special-purpose refractory

The feeder channel pictured above uses MONOFRAX M fused-cast refractories—from feeder entrance up to feeder bowl. Here are the reasons:

(1) MONOFRAX M refractory resists erosion with exceptional success. That's because the refractory crystals are small and tightly interlocked.

(2) It also minimizes refractory-caused contamination. In fact, it's *the* purest of all commercial fused-cast refractories. It consists of over 98% alumina with less than 0.2% impurities. These properties of Type M also explain its use in the complete melting-end sidewalls. (MONOFRAX H refractory is used in the tuckstones, port bottoms, bridge wall runners and shadow wall in the tank described here.)

Four MONOFRAX compositions make up a complete line that is designed to meet *all types of tank* service. Each is peculiarly suited for certain glass compositions . . . tank designs . . . or tank areas. Our engineers have the experience—*and the special-purpose refractories*—to help you deliver quality glass at lowest refractory cost. So make a mental note to exchange thinking with our local refractory engineer. For his name, write: The Carborundum Company, Perth Amboy, N. J., Dept. L-128.

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(*Continued from page 666*)

air burners which formed the available thermoplastic tubing into scientific apparatus). But those who postulated were wrong. In fact, a new and great industry grew from the combination of fiberglass and plastics. Plastic closures have been used on glass vials and bottles for years. The benefits of combining glass apparatus with plastics appeared recently in a new product, a graduated laboratory cylinder with plastic base, introduced by the Corning Glass Works. Low-cost, durable and eye appealing plastic components, such as bases, handles and hose connectors, provide a new dimension for apparatus construction.

A further reason for combining plastic with glass, is to provide glass apparatus with improved chemical and physical properties available from some plastics. For example, the inherent properties of Teflon* are used to advantage in stopcock plugs, ground joint liners and gaskets for glass pipe flanges. A new vapor process[18] applies tenacious films (0.00008" to 0.003" thick) of Teflon to glassware. The coatings are free of pinholes. For all practical purposes, this method provides a variety of Teflon apparatus to be manufactured by special, or production, glass-forming methods.

One word more on plastics, "Silicone." Transparent coatings of this material are extending the number of trips for return-bottles by preventing surface abrasion. Scientific apparatus, subject to rough handling, can also benefit from these coatings.

Glass in combination with plastics has found a place in modern apparatus design.

Glass - Metals

The improved glass sealing alloys, developed for the electronic tube industry, will find new applications by today's space-age scientist. As an engineering material, glass combined with these metals offers insulated support and rugged containers for sensitive measuring devices.

Along these same lines, fired-on coatings of silver and platinum will continue to find new uses. The reliability, for soft solder seals, electrical connections and printed circuits, has been proven.

Powdered Glass

Some limitations of conventional glass working may be overcome by powdered glass techniques. This is especially true when small, complex parts are required. Dorgelo[19] described a method for making vacuum tube headers with powdered glass, metal pins and a molding jig. These principles may be applied to forming multiple-hole discs by dissolving out the metal with acid.

Powdered, low melting, solder glass has been used for many years to join glass to glass and glass to other materials. Recently, the maximum operating temperature of solder glass, a limiting factor, was extended by the introduction of Pyroceram Cement.

Scientific Glass-Blowing: 2000 A.D.

The practice of gazing into the mystical crystal ball has long been abandoned as an unscientific method of

*Teflon (polytetrafluorethylene) is a product of E. I. du Pont de Nemours & Co.

predicting. However, for this discussion on scientific glass blowing, it appears justified to invert a round-bottom laboratory flask for just one last quick look.

It is now 2000 A.D.; the glass blowers we see appear to be using solar energy to soften glass tubing—a method used about the middle of the 20th century to melt and study new glasses in the laboratory. That camera shutter, mounted on the bench, appears to provide perfect sunbeam (flame) size control. Obviously, these people must make apparatus only when the sun shines. But look, the piece that just fell to the floor bounced—they're using malleable glass—it's unbreakable! See here, in this other room. Can they be chemical glassworkers? These people are processing Vycor and the chemical machining glass, Photoform, patented years ago by the Corning Glass Works. Apparently, time has made the manufacturing problems routine.

Back once again to reality, where we find today's scientific glass blowers eager to improve their knowledge of glass to better cope with the unknown future. Modern scientific glass blowers are keeping pace with present day technology.

Summary

The growth of scientific glass blowing resulted from the need for complex apparatus and the fact that it became impractical to form this apparatus from gobs of molten glass on the end of a long metal blowpipe. A simplified method was to draw the molten glass into tubing and later shape the tubing into apparatus by heating with a bench burner, also called a blowpipe.

Industries using glass in their products contributed many new materials and methods; for example, the glass lathe and metal-glass seals.

Some currently used techniques, as template paddle forming and vacuum forming, are offered as solutions for precision fabricating problems. The scientific glass blower will play an important part in the expanding field of science and scientific glass blowing.

ACKNOWLEDGMENT

The writer is indebted to Dan Lazare of the Research Laboratories, Sylvania Electric Products, Inc., for his assistance in preparing the original paper presented at the Second Symposium of the American Scientific Glass Blowers Society at Corning Glass Works, Corning, N.Y., on June 1, 1957. Also, I am grateful to George Bergen, a scientific glass blower, for drawing the historical chart (Fig. 1) on page 642.

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(*Continued on page* 671)

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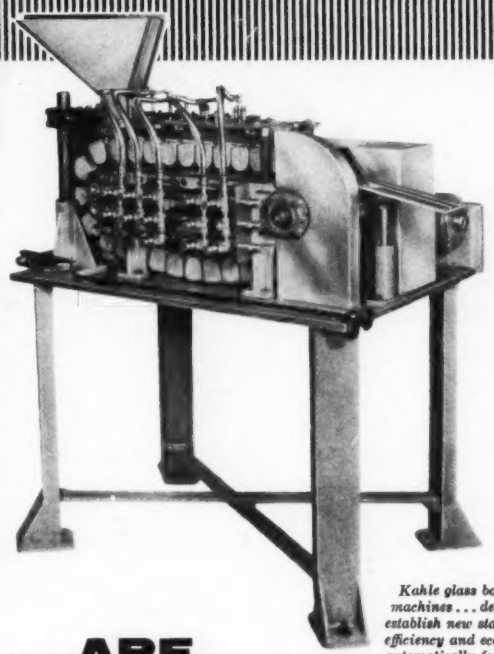

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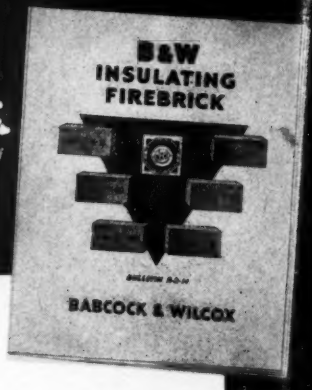

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(*Continued from page* 669)

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Picture Credits

Fisher Scientific Company: Figs. 2, 3, 7, 8, 9, 14.

Sylvania Electric Products: Figs. 5, 6, 10, 12, 13, and Cover.

Recent Translations of Russian Papers

(*Continued from page* 649)

native quartz dust available in the Ural mountains. This dust has a large fraction (e.g., 45 per cent of particles smaller than 0.01 mm. in diameter. It contains 90-99 per cent SiO_2, 0.2-6.7 per cent Al_2O_3, 0.1-0.7 per cent Fe_2O_3, 0.5-1.5 per cent ignition loss, and so on. The iron compounds can be removed in the usual manner.

In glass batches, quartz dust can advantageously be substituted for sand because small particle size results in a quicker melting. Experimental meltings in pots produced satisfactory glasses without color or air bells.

FRANK DAY WITH FIBERGLAS

Dr. Frank Day has been appointed to the staff of the Basic and Applied Research Laboratories of Owens-Corning Fiberglas Corporation at Newark, Ohio. He will be manager of the melting research laboratory. With Corning Glass Works for 17 years, Dr. Day was most recently manager of the chemical services department.

SHORT COURSE: QUALITY CONTROL

The College of Engineering, University of Illinois, with the cooperation of the division of Engineering Extension at Urbana, is giving the twelfth annual short course in Quality Control by Statistical Methods from January 26 through February 5, 1959.

Emphasis will be placed on the fields of control charts and acceptance sampling, with some attention given to the rational setting of specifications and tolerances. Additional information may be obtained from Professor John A. Henry, Room 205, Mechanical Engineering Laboratory, University of Illinois, Urbana, Illinois.

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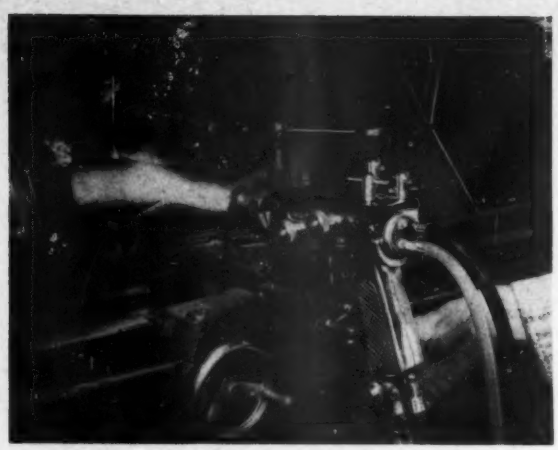

Plungers Last 15 Times Longer with Colmonoy Protection

Colmonoy Sprayweld hard surfacing has radically increased the life of glass plungers in glass container plants everywhere. Reports show at least 15 times (and up to 54 times) longer life can be expected from Colmonoy protected plungers.

As originators of the Sprayweld* Process (spraying and fusing hard-surfacing alloys), and with eight years of experience in the maintenance of glass plant machinery, only Colmonoy offers a dependable, complete line of alloys in forms for every application method. The Colmonoy Spraywelder (a powder metal spray gun) produces superior uniform overlays, uses compressed air to build dense porosity-free deposits. Colmonoy alloys, containing chromium borides, provide maximum wear life, improve finished ware by eliminating specks.

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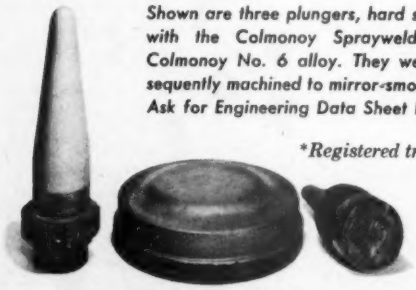

Shown are three plungers, hard surfaced with the Colmonoy Spraywelder and Colmonoy No. 6 alloy. They were subsequently machined to mirror-smoothness. Ask for Engineering Data Sheet No. 34.

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APPOINTED BY O-I

Earl F. Schaefer has become control laboratory supervisor in charge of furnaces, glass and ceramic colors for the glass container division of Owens-Illinois, succeeding Joseph W. Wright. Mr. Wright held that position for 28 years and will now be on special assignments upon returning from an extended vacation.

Earl F. Schaefer

Jess H. Parmer, Jr., was appointed assistant coordinator of plant research and development laboratories.

TILTON RETIRES FROM N.B.S.

Leroy W. Tilton, assistant to the chief of the Optics and Metrology division of the National Bureau of Standards, retired on September 30. He had been with the Bureau for 37 years. An expert on the optical properties of transparent media, he has worked on refractometers and refractive index measurements, optical height and range finders, and studies of the homogeneity of optical glass.

MINNESOTA SECTION OF A.C.S.

I. J. McKeand, Minneapolis Honeywell Regulator Co., has been elected chairman of the Minnesota section of the American Ceramic Society. Other officers who were named are: N. H. Stradley, chairman-elect, and M. A. Knight, vice chairman (both of Minnesota Mining & Manufacturing Co.); and W. Fenton, Lithium Corporation of America, Inc., secretary.

Inventions and Inventors

(*Continued from page* 652)

central cavity of the disc whereby the aforesaid disadvantages are avoided and furthermore to create other advantages which will appear from the following description.

The present invention consists in conducting the suspension of abrasive from the hollow driving shaft of a bottom grinding disc through conduits into the inner end channels in the disc which separate the nogs, in contra-distinction to present practice in which the suspension is supplied to the channels from the central cavity itself, the wall of the central cavity being formed with apertures through which cullet may escape during operation of the machine.

It may be advantageous to cause the conduits which thus feed the suspension of abrasive to the channels to open into a trough formed near the wall of the central cavity, the trough being formed to direct the suspension received from the conduits towards the channels opening into the central cavity.

The risks of obstruction by cullet previously referred to are eliminated by means of the present invention. In this way, to a great extent, one can avoid small fragments of glass being taken by the abrasive liquid into

the channels between the nogs blocks. It is known that in the usual tools these fragments escape when the ends of the channels overlap the ribbon of glass but are then knocked by the nog against the edges of the sheet which they splinter, creating the starting points for breakage.

Furthermore, the apertures formed in the wall of the central cavity in accordance with the present invention provide the further advantage of putting the latter into communication with the atmosphere and of thus eliminating the creation of a vacuum which would tend to be created under the ribbon of glass with the usual tools with an airtight central cavity, at the moment of starting up, which vacuum is represented by a suction likely to cause such a deflection of the glass into the cavity as to lead to breakage of the ribbon of glass.

There were 4 claims and the following references.

United States Patents

2,646,655, Laverdisse, July 28, 1953 and 2,673,428, Cook, Mar. 30, 1954.

Foreign Patents

729,683, Great Britain, May 11, 1955.

Tube and Cane Machines

Method of manufacture of a lamp envelope. Patent No. 2,822,646. Filed March 30, 1955. Issued February 11, 1958. No sheets of drawings; none reproduced. Assigned to Hanovia Chemical & Mfg. Company by Hermann E. Krefft.

The invention relates to envelopes for electrical discharge or vacuum devices made from clear fused silica.

The manufacture of a lamp envelope comprises the steps of sealing one end of an elongated thick-walled tubular or cylindrical part of clear fused silica into an opening provided in the center of a plane disc consisting of the same vitreous material and having a circular shape and comparable wall thickness, but of larger diameter than said part, said part being vertically positioned, with respect to said disc, heating said disc to a high working temperature and subsequently molding it over a mandrel having the size and shape of the internal surface of a section of the envelope by means of a molding tool, thus forming a molded section of the envelope, cutting and/or grinding the rim of said section in a plane perpendicular to the axis of said part and producing a flat annular edge for engagement with the edge of another such section having a similar shape, sealing the edges of said sections together to form a complete envelope.

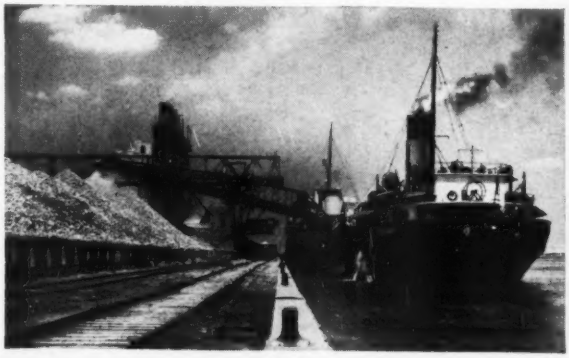
The invention is based on the fact that in the manufacture of clear fused silica, as a first step, a solid cylindrical slug of considerable diameter is formed from small particles which are fused together under a high temperature. This slug is subsequently pierced axially and transformed into tubing by a drawing process.

In accordance with the invention, this last step is eliminated, and instead, a pair of plane discs of circular shape cut from the original solid or pierced slug and having a suitable thickness is used as raw material from which a pair of sections is formed by molding, which pair is subsequently sealed together and constitutes the desired body for the envelope. In order to carry out this procedure and obtain an envelope provided with one neck or two co-axial necks arranged on opposite ends

Milestones in Glass Progress

PHOTO COURTESY JAMESTOWN GLASSHOUSE FOUNDATION

1608-1958 This year marks the 350th anniversary of the birth of glassmaking—America's first industry. In 1956, on the site of the original "Glasshouse," in Jamestown, Virginia, reconstruction of the 1608 "factory" was completed (illus.). It serves as a lasting tribute to the early-day craftsmen of the glass industry.



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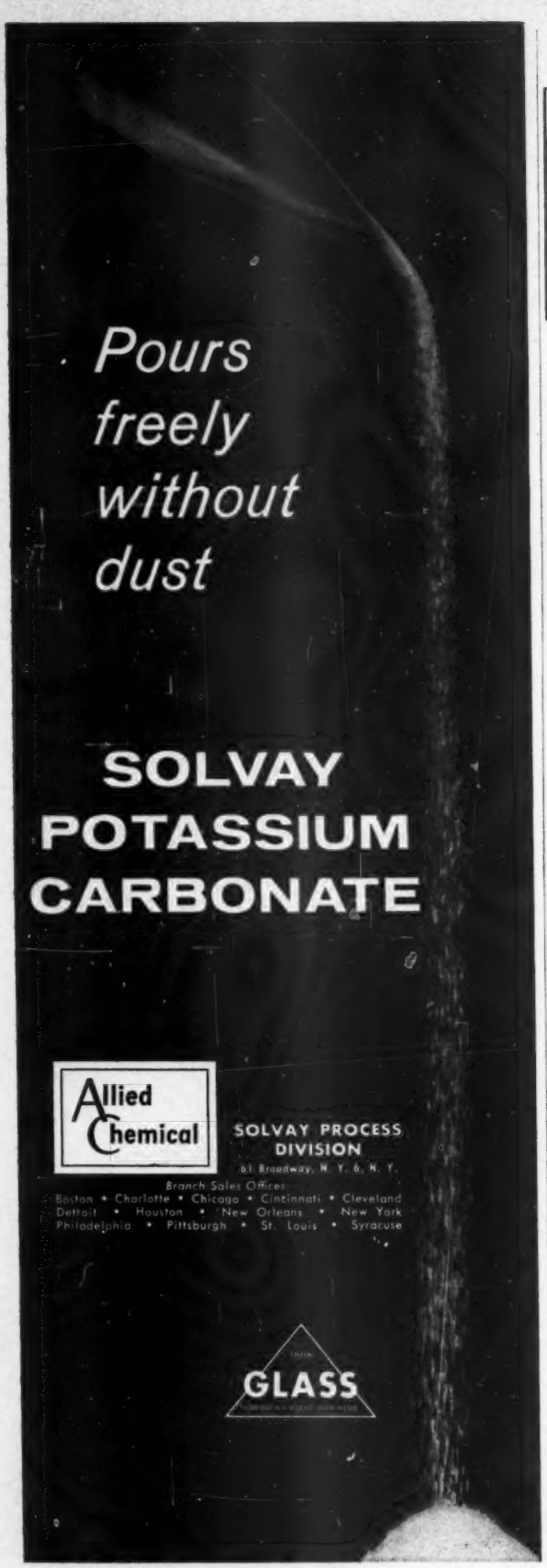

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of the envelope body, each disc is provided, prior to the molding process, with an axial tube or rod.

There were five claims and the following references cited in this patent.

United States Patents

2,235,515, Carpenter, Mar. 18, 1941; 2,248,644, Reger et al., July 8, 1941; 2,346,470, Cary, Apr. 11, 1944; 2,383,098, Wheaton, Aug. 21, 1945; 2,413,338, Small, Dec. 31, 1946; 2,465,123, Ruff, Mar. 22, 1949; and 2,500,384, Schell, Mar. 14, 1950.

Foreign Patents

326,904, Germany, Nov. 16, 1915.

Miscellaneous Processes

Apparatus for Coating Metallic Anode Buttons. Patent No. 2,786,442. Filed September 2, 1953. Issued March 26, 1957. Three sheets of drawings; none reproduced. Assigned to Owens-Illinois Glass Company, by George E. Keefer.

This invention relates to glass-to-metal seals and particularly to an apparatus for coating metallic anode buttons with a layer of glass, prior to inserting said buttons in cathode ray tubes.

In the glass-to-metal sealing art, it has generally been known that the glass and metal must have substantially the same thermal expansion characteristics in order to prevent residual stresses from forming in the seal. It has been suggested that the strength of the seal may be improved by application of an oxide coating to the metal prior to sealing and by fusing a glass glaze or coating to the metal prior to sealing. The glass is applied by dipping or spraying a mixture containing a glass powder or frit and a suitable carrying vehicle. The coated metal is then heated to fuse the glass thereto.

This invention comprises two substantially similar units mounted on either side of a conveyor. Each of the units includes an annular series of spindles for carrying the anode buttons. Means are provided for successively feeding buttons to the spindles and applying the coating to each button by spraying. In addition, each unit includes means for transferring the coated buttons to the conveyor, which in turn carries the coated buttons through an oven where the coating is fused to the buttons. As presently used in practice the metallic anode buttons are generally frustoconical in shape.

One claim and 15 references were cited in the above patent.

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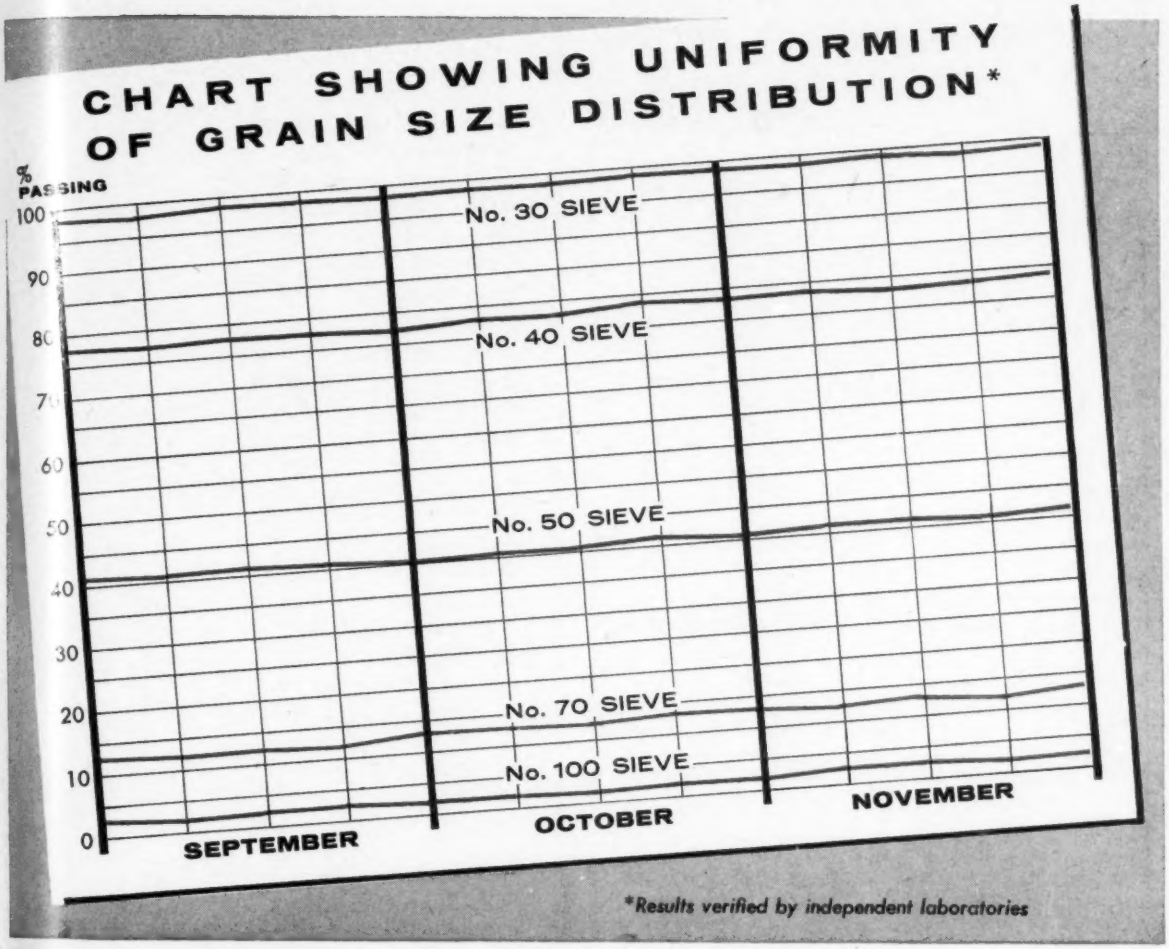

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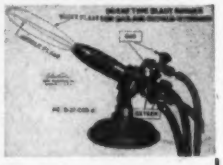

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CHEMISTS AND CONSULTING
ENGINEERS
FOR THE GLASS INDUSTRY

LANCASTER, OHIO U. S. A.

THE SOVIETS ON GLASS

Translated from Russian into English

The Structure of Glass. Translated into English from Russian and published by the Consultants Bureau, Inc., 227 West 17th St., New York 11, N. Y., 295 pp., including all original tabular, diagrammatic and photographic material, case-bound, $20, postage included. Translation was sponsored by the Glass Division of The American Ceramic Society and the National Science Foundation to provide better access to Soviet literature on glass science. This authoritative volume, containing 75 outstanding glass papers, details the most recent theoretical and practical developments by the leading Soviet researchers. Papers were presented at a conference convened by the Institute of Silicate Chemistry of the Academy of Sciences of the USSR and other affiliated organizations meeting in Leningrad.

Among the subjects covered are: Use of Spectroscopic Methods; Effects of Temperature on the Refractive Index and Coefficient of Expansion; Application of X-ray, Electron and Neutron Diffraction Methods; and other integral aspects—all presented in a sincere attempt to throw new light on the unknown factors encountered in a study of the glassy state, and to further develop its as yet unutilized rich potentialities.

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INDEX TO ADVERTISERS

	Page
American Ceramic Society, The Glass Division	676
American Potash & Chemical Corp.	628
Babcock & Wilcox Company	670
Cambridge Wire Cloth Company	650
Carborundum Company, The	667
Carlisle Glass Burner Corp.	664
Classified	674
Columbia-Southern Chemical Corporation	636
Corhart Refractories Company	623
Eisler Engineering Co., Inc.	676
Emhart Manufacturing Company, Hartford-Empire Division	624
Exact Weight Scale Company	671
Fansteel Metallurgical Corp.	630
Frazier-Simplex, Inc.	621
Harshaw Chemical Company, The	Cover II
Heavy Minerals Co.	668
Hommel Company, The O.	627
Kahle Engineering Company	669
Kaiser Aluminum & Chemical Corp.	625
Lawson-United Feldspar & Mineral Company	626
Lindsay Chemical Division, American Potash & Chemical Corp.	661
Olin Mathieson Chemical Corporation	664
Overmyer Mould Co., Inc., The	629
Pennsylvania Glass Sand Corp.	675
Selas Corporation of America	632
Sharp Schurtz Company	676
Solvay Process Division, Allied Chemical Corporation	674
Surface Combustion Corporation	Cover IV
Taylor Sons Company, Chas., The	Cover III
Toledo Engineering Company	665
United States Borax & Chemical Corp., Pacific Coast Borax Company Div.	631
Wall Colmonoy Corp.	672
Walsh Refractories Corporation	635
Wedron Silica Company	663
West End Chemical Company	633
Westvaco Chlor-Alkali Division, Food Machinery & Chemical Corp.	634
Wyandotte Chemicals Corp.	673

Index of THE GLASS INDUSTRY for 1958

A

Accelerator for Glass Polishing *July p.* 386
Acid Polishing of Glass *Oct p.* 560
Adhesion of Molten Glass to Molds *May p.* 276
A. C. S. Will Observe 60th Anniversary at Annual Meeting in Pittsburgh *Apr p.* 199
A. C. S. West Coast Meeting *Dec p.* 647
Ancient and Modern Diatreta, by Albert Christian Revi *Aug p.* 428
Annealing in a Polarimeter, Determination of the Degree of *Oct p.* 560
Annual Review of the Glass Industry—1958, by H. E. Simpson *Jan p.* 17
Apparatus for Measuring Wall Thicknesses of Hollow Glass Vessels, by Vivian Bird *Aug p.* 430

B

Barteney, G. M., and A. I. Ivanova, Testing Glass for Strength; Translated by Charles H. Greene and Charles D. Buchanan *Aug p.* 423
Belgium Builds Largest Glass Furnace *Feb p.* 97
Bending Operations, Radiant Gas Heat in Glass, by Harold A. McMaster *Aug p.* 426
Bird, Vivian, Apparatus for Measuring Wall Thicknesses of Hollow Glass Vessels *Aug p.* 430
Bleininger Award, Alexander Silverman Receives *Apr p.* 210
Borel, Edward, A Drawn Sheet Glass Process of 1871; Translated by S. R. Scholes *Sept p.* 482
Boring and Grinding, Supersonic *May p.* 278

C

Carnes, K. C., Ford's New Nashville Glass Furnaces *May p.* 270
Color Standards, Safety *Oct p.* 569
Container Glass Compositions (1932-1957), A Review of, by W. R. Lester *Dec p.* 637
Cooling Wind Control for Glass Forehearths, by Paul M. Spatz and Richard Post *May p.* 265
Corning's New Apparatus Plant at Big Flats *Sept p.* 478
Current Statistical Position of Glass: *Jan p.* 47; *Feb p.* 105; *Mar p.* 163; *Apr p.* 225; *May p.* 285; *June p.* 341; *July p.* 391; *Aug p.* 437; *Sept p.* 489; *Oct p.* 548; *Nov p.* 601; *Dec p.* 655.

D

Debiteuse, Manufacture of Glass Tubing Without A *Oct p.* 539
De Maria, Vincent D., Highlights of Scientific Glass Blowing *Dec p.* 642
Devitrification, Effect of Magnesium Oxide on *May p.* 276; Of Window Glass *May p.* 276; and Chemical Composition *May p.* 278
Diatreta, Ancient and Modern, by Albert Christian Revi *Aug p.* 428
Dispersions, Glasses with High Refractive Indices and *Nov p.* 594
Drawn Sheet Glass Process, A, of 1871, by Edward Borel; Translated by S. R. Scholes *Sept p.* 482

E

Edens, A. H., Sealing the Window and Cone of Television Tubes *Oct p.* 535
Eighteenth Conference on Glass Problems *Jan p.* 32
Eitel, Wilhelm (Translator), Spectra of Simple Glasses in the Infrared Range and Their Relations to the Structure of Glass, by V. A. Florinskaya and R. S. Pechenkina, Part I *Jan p.* 27; Part II *Feb p.* 93; Part III *Mar p.* 151
Elmer, Thomas H. (Translator), Flame Studies: Methods and Results, by Rudolf Gunther *Sept p.* 473
End Port Regenerator Furnaces, Performance Data on, by Henry Moore *Oct p.* 531
Endurance of Glass in Boiling Water *May p.* 276
Equipment and Supplies (See "New Equipment and Supplies")

F

Fineness of Batch, Effect of, on the Rate of Melting *Oct p.* 562
Flame Studies; Methods and Results, by Rudolf Gunther; Translated by Thomas H. Elmer *Sept p.* 473
Fluorine, Loss of, in the Manufacture of Milk Glass *May p.* 277
Ford's New Nashville Glass Furnaces, by K. C. Carnes *May p.* 270
Forehearths, Cooling Wind Control for Glass, by Paul M. Spatz and Richard Post *May p.* 265
Fry, Harry, Thickness of a Silver Mirror Film and the Iodine Ring Method *June p.* 328
Furnace, Glass, Belgium Builds Largest *Feb p.* 97
Furnaces, Ford's New Nashville Glass, by K. C. Carnes *May p.* 270.
Furnaces, Performance Data on End Port Regenerator, by Henry Moore *Oct p.* 531
Furnaces, Side Port, by Fred M. Merritt *July p.* 375

G

Gas Heat, Radiant, in Glass Bending Operations, by Harold A. McMaster *Aug p.* 426
Glass Blowers in Business, Teen Age, by H. H. Slawson *Sept p.* 484
Glass Blowing, Highlights of Scientific, by Vincent D. De Maria *Dec p.* 642
Glass Compositions (1932-1957), A Review of Container, by W. R. Lester *Dec p.* 637
Glass Conference Papers, Summaries:
Automatic Recording and Controlling of Flue Gases, by R. K. Gunsaulus *June p.* 331

Glass Conference Papers, Summaries (*Continued*)
Practical Application of Flue Gas Analysis to Glass Melting Furnaces, by Paul M. Spatz *June* p. 332
Fluorspar for the Glass Industry, by Robert C. Keaney *Oct* p. 541
Direct-Fired Continuous Glass-Melting Furnaces, by A. K. Lyle *Oct* p. 541
All-Electric Glass-Melting Furnaces, by Allen J. Erickson *Oct* p. 556
G. C. M. I. Spring Meeting *July* p. 378
Glass Cutter, A, for Cutting off Edges *May* p. 277
Glass Division Papers at 60th Annual A. C. S. Meeting *June* p 321
Glass Division Program at Bedford Springs *Oct* p. 533; Review of Meeting *Nov* p. 590
Glass Forehearths, Cooling Wind Control for, by Paul M. Spatz and Richard Post *May* p. 265
Glass Furnace, Belgium Builds Largest *Feb* p. 97
Glass Industry—1957, Annual Review of, by H. E. Simpson *Jan* p. 17
Glass: Its Transparency and Structure, by H. H. Holscher, Part I *Feb* p. 81; Part II *Mar* p. 143; Part III *Apr* p. 212
Glass Making, Native Quartz Dust in *Dec* p. 649
Glass Polishing, Accelerators for *July* p. 386
Glass Problems, Eighteenth Conference on *Jan* p. 32
Glass, Spun: Its Genesis and Development, by Albert Christian Revi *June* p. 325
Glass Structure, Modern Concepts of, by L. Prod'homme; Translated by Norbert J. Kreidl *Nov* p. 587
Glass Structures, Use of X-Ray Methods for Investigations of, by Kai Grjotheim *Apr* p. 201
Glass Tubing without A Debiteuse, Manufacture of *Oct* p. 539
Glasses with High Refractive Indices and Dispersions *Nov* p. 594
Greene, Charles H. and Charles D. Buchanan (Translators), Testing Glass for Strength, by G. M. Barteney and A. I. Ivanova *Aug* p. 423
Grinding, Supersonic Boring and *May* p. 278
Grjotheim, Kai, Use of X-Ray Methods for Investigations of Glass Structures *Apr* p. 201
Ground Glass, The Surface of *May* p. 276
Gunther, Rudolf, Flame Studies: Methods and Results. Translated by Thomas H. Elmer *Sept* p. 473

H

Heat-Resistant Tubing of Alkali-Free Glass *July* p. 385
Highlights of Scientific Glass Blowing, by Vincent D. DeMaria *Dec* p. 642
High Refractive Indices and Dispersions, Glasses with *Nov* p. 594
High Temperature Measurements *Sept* p. 480
Holscher, H. H., Glass: Its Transparency and Structure, Part I *Feb* p. 81; Part II *Mar* p. 143; Part III *Apr* p. 212
Hopkins, R. W. and W. H. Manring, Use of Sulfates in Glass *Mar* p. 139

I

Immiscibility in Oxide Systems, Structural Interpretation of *Mar* p. 155
Interpretation of Glass Stability *Aug* p. 431
Inventions and Inventors:
Annealing and Tempering: *Jan* p. 39; *Feb* p. 99; *Mar* p. 157; *Apr* p. 221; *May* p. 279; *June* p. 335; *July* p. 387; *Aug* p. 433; *Sept* p. 486; *Oct* 543; *Nov* p. 597; *Dec* p. 651
Feeding and Forming: *Jan* p. 39; *Feb* p. 99; *Mar* p. 157; *Apr* p. 221; *May* p. 279; *June* p. 335; *July* p. 387; *Aug* p. 433; *Sept* p. 486; *Oct* p. 544; *Nov* p. 651; *Dec* p. 651
Furnaces: *Jan* p. 39; *Feb* p. 99; *Mar* p. 157; *Apr.* 221; *May* p. 279; *June* p. 335; *July* p. 388; *Sept* p. 486; *Oct* p. 544; *Nov* p. 608; *Dec* p. 651
Glass Compositions: *Jan* p. 39; *Feb* p. 100; *Mar* p. 158; *Apr* p. 221; *May* p. 280; *June* p. 336; *July* p. 388; *Aug* p. 434; *Sept* p. 486; *Oct* p. 545; *Dec* p. 651
Glass Wool and Fiber: *Jan* p. 39; *Feb* p. 100; *Mar* p. 158; *Apr* p. 222; *May* p. 280; *June* p. 336; *July* p. 400; *Aug* p. 447; *Sept* p. 512; *Oct* p. 545; *Dec* p. 652
Sheet and Plate Glass: *Jan* p. 40; *Feb* p. 100; *Mar* p. 159; *Apr* p. 222; *May* p. 281; *June* p. 337; *July* p. 402; *Aug* p. 448; *Sept* p. 512; *Oct* p. 566; *Dec* p. 652
Tube and Cane Machines: *Jan* p. 41; *Feb* p. 101; *Mar* p. 159; *Apr* p. 223; *May* p. 282; *June* p. 338; *July* p. 404; *Aug* p. 448; *Sept* p. 513; *Oct* p. 568
Miscellaneous Processes: *Jan* p. 41; *Feb* p. 101; *Mar* p. 160; *Apr* p. 223; *May* p. 298; *June* p. 338; *July* p. 406; *Aug* p. 450; *Sept* p. 513; *Nov* p. 610; *Dec* p. 674
Iodine Ring Method, Thickness of a Silver Mirror Film and the, by Harry Fry *June* p. 328
Ivanova, A. I. and G. M. Barteney, Testing Glass for Strength. Translated by Charles H. Greene and Charles D. Buchanan *Aug* p. 423

K

Kreidl, Norbert J. (translator), Modern Concepts of Glass Structure, by L. Prod'homme *Nov* p. 587

L

Laboratory Glass, A New *May* p. 276
Laboratory Glasses, Comparison of Some *July* p. 386
Lester, W. R., A Review of Container Glass Compositions (1932-1957) *Dec* p. 637
Littleton Receives Toledo Award *Feb* p. 90

M

Magnesia-Alumina Glasses, Properties of Some *May* p. 275
Magnesium Oxide, Effect of, on Devitrification *May* p. 276
Manring, W. H. and R. W. Hopkins, Use of Sulfates in Glass *Mar* p. 139
Manufacture of Glass Tubing without a Debiteuse *Oct* p. 539
Mathematics of Grinding and Polishing Sheet Glass *Dec* p. 649
Measuring Wall Thicknesses of Hollow Glass Vessels, Apparatus for, by Vivian Bird *Aug* p. 430

Meetings:
A.C.S. 60th Annual Meeting *Apr p.* 199; *June p.* 321
A.C.S. West Coast Meeting *Dec p.* 647
Conference, 18th, on Glass Problems *Jan p.* 32
G.C.M.I. Spring Meeting *July p.* 378
Glass Division Fall *Oct p.* 533; *Nov p.* 590
Optical Society Meeting, Washington, D. C. *May p.* 269; Detroit *Nov p.* 595
Overmyer Iron Clinic, Eighth *July p.* 380
Merritt, Fred M., Side Port Furnaces *July p.* 375
Milk Glass, Loss of Fluorine in the Manufacture of *May p.* 277
Mirror Film, Thickness of A, and the Iodine Ring Method, by Harry Fry *June p.* 328
Mirror Glass, Price Structure of Window and *May p.* 277
Modern Concepts of Glass Structure, by L. Prod'homme; Translated by Norbert J. Kreidl *Nov p.* 587
Molds, Adhesion of Molten Glass to *May p.* 276
Molten Glass, Adhesion of, to Molds *May p.* 276; in Electric Furnaces, Determining the Electric Resistance of *Oct p.* 560
Moore, Henry, Performance Data on End Port Regenerator Furnaces *Oct p.* 531

N

New Equipment and Supplies: *Jan p.* 49; *Feb p.* 106; *Mar p.* 164; *Apr p.* 226; *May p.* 287; *June p.* 342; *July p.* 392; *Aug p.* 438; *Sept p.* 491; *Oct p.* 549; *Nov p.* 601; *Dec p.* 657

O

Optical Society Meeting in Washington, D.C. *May p.* 269; in Detroit *Nov p.* 595
Overmyer Iron Clinic, Eighth *July p.* 380
Owens-Illinois Warehouse Assures Product Protection *Oct p.* 540
Oxide Systems, Structural Interpretation of Immiscibility in *Mar p.* 155

P

Performance Data on End Port Regenerator Furnaces, by Henry Moore *Oct p.* 531
Polished Glass, Surface of *Oct p.* 560
Polishing, Surface Temperature of Glass During *May p.* 278
Porous Glass, Formation of *July p.* 385
Post, Richard, and Paul M. Spatz, Cooling Wind Control for Glass Forehearths *May p.* 265
Price Structure of Window and Mirror Glass *May p.* 277
Prod'homme, L. G., Modern Concepts of Glass Structure; Translated by Norbert J. Kreidl *Nov p.* 587
Properties of Some Magnesia-Alumina Glasses *May p.* 275

Q

Quartz Dust in Glass Making, Native *Dec p.* 649

R

Radiant Gas Heat in Glass Bending Operations, by Harold A. McMaster *Aug p.* 426
Recent Translations of Russian Papers of Interest to the Glass Industry *May p.* 275; *July p.* 385; *Oct p.* 539; *Dec p.* 649. (See also Translations)
Regenerator Furnaces, Performance Data on End Port, by Henry Moore *Oct p.* 531
Research Digest:
Mixing and Flow in Tank Furnaces *Jan p.* 45;
Fracture of Glass Under Various Liquids and Gases *Feb* 103;
Bonded Mullite and Zircon Refractories for the Glass Industry *Mar p.* 161;
A Study, on Models, of the Effects of Operations and Design on the Glass Flow in Tank Furnaces *Apr p.* 224;
Determination and Use of the Sag Point as a Reference Point in the Heating of Glasses *May p.* 283;
Reduction Effects in Molten Glass *June p.* 339;
Inhibition of Alkaline Attack on Soda-Lime Glass *July p.* 389;
The Effect of Sand Grain Size on the Refining of a Pure Soda-Lime-Silica Glass *Aug p.* 435;
Selenium Utilization in Soda-Lime-Silica Glass Manufacture *Sept p.* 487;
Glass Level Measurement in Furnaces *Oct p.* 547;
Silicone Films on Glass Surfaces *Nov p.* 599;
Color and Light Scattering of Platinum in Some Lead Glasses *Dec p.* 653
Revi, Albert Christian, Spun Glass: Its Genesis and Development *June p.* 325; Ancient and Modern Diatreta *Aug p.* 428
Review of Container Glass Compositions (1932-1957), by W. R. Lester *Dec p.* 637

S

Safety Color Standards *Oct p.* 569
Scholes, S. R. (Translator), A Drawn Sheet Glass Process of 1871, by Edward Borel *Sept* p. 482
Scientific Glass Blowing, Highlights of, by Vincent D. DeMaria *Dec p.* 642
Sealing the Window and Cone of Television Tubes, by A. H. Edens *Oct p.* 535
Sharp, Donald E.: In Memoriam *July p.* 383
Sheet Glass, Mathematics of Grinding and Polishing *Dec p.* 649; Measurement of Stresses in *Dec p.* 649
Sheet Glass Process of 1871, A Drawn, by Edward Borel; Translated by S. R. Scholes *Sept p.* 482
Side Port Furnaces, by Fred M. Merritt *July p.* 375
Silverman, Alexander, Receives Bleininger Award *Apr p.* 210
Slawson, H. H., Teen Age Glass Blowers in Business *Sept p.* 484
Soda-Rich Glasses, Crystalline Components of *Oct p.* 563
Spatz, Paul M. and Richard Post, Cooling Wind Control for Glass Forehearths *May p.* 265
Spectra of Simple Glasses in the Infrared Range and Their Relations to the Structure of Glass, by V. A. Florinskaya and R. S. Pechenkina; Translated by Wilhelm Eitel, Part I *Jan p.* 27; Part II *Feb p.* 93; Part III *Mar p.* 151
Spun Glass: Its Genesis and Development, by Albert Christian Revi *June p.* 325
Stability, Interpretation of Glass *Aug p.* 431
Statistics (see Current Statistical Position of Glass)

Strength of Glass, Effect of Treatment on the *July p.* 386
Strength, Testing Glass for, by G. M. Barteney and A. I. Ivanova; Translated by Charles H. Greene and Charles D. Buchanan *Aug p.* 423
Stresses in Sheet Glass, Measurement of *Dec p.* 649
Structural Interpretation of Immiscibility in Oxide Systems *Mar p.* 155
Structure and Transparency of Glass, by H. H. Holscher, Part I *Fed p.* 81; Part II *Mar p.* 143; Part III *Apr p.* 212
Structure of Glass, Spectra of Simple Glasses in the Infrared Range and their Relations to the, by V. A. Florinskaya and R. S. Pechenkina; Translated by Wilhelm Eitel, Part I *Jan p.* 27; Part II *Feb p.* 93; Part III *Mar p.* 151
Structures, Glass, Use of X-Ray Methods for Investigations of, by Kai Grjotheim *Apr p.* 201
Sulfates in Glass, Use of, by W. H. Manring and R. W. Hopkins *Mar p.* 139
Summaries of Glass Conference Papers *June p.* 331; *Oct p.* 541
Surface Temperature of Glass During Polishing *May p.* 278
Supersonic Boring and Grinding *May p.* 278
Surface of Ground Glass, The *May p.* 276

T

Teen Age Glass Blowers in Business, by H. H. Slawson *Sept p.* 484
Temperature, Surface, of Glass During Polishing *May p.* 278
Testing Glass for Strength, by G. M. Barteney and A. I. Ivanova; Translated by Charles H. Greene and Charles D. Buchanan *Aug p.* 423
Thickness of a Silver Mirror Film and the Iodine Ring Method, by Harry Fry *June p.* 328
Toledo Award, Littleton Receives *Feb p.* 90
Translations:
Russian: *May p.* 275; *July p.* 385; *Oct p.* 539; *Dec p.* 649
Testing Glass for Strength, by A. I. Ivanova and G. M. Barteney *Aug p.* 423
German: Spectra of Simple Glasses in the Infrared Range and Their Relations to the Structure of Glass, by V. A. Florinskaya and R. S. Pechenkina, Part I *Jan p.* 27; Part II *Feb p.* 93; Part III *Mar p.* 151
Flame Studies: Methods and Results, by Rudolf Gunther *Sept p.* 473
French: A Drawn Sheet Glass Process of 1871, by Edward Borel *Sept p.* 482
Modern Concepts of Glass Structure, by L. Prod'homme *Nov p.* 587
Transparency and Structure of Glass, by H. H. Holscher, Part I *Feb p.* 81; Part II *Mar p.* 143; Part III *Apr p.* 212
Tubes, Television, Sealing and Window and Cone of, by A. H. Edens *Oct p.* 535

U

Use of Sulfates in Glass, by W. H. Manring and R. W. Hopkins *Mar p.* 139
Use of X-Ray Methods for Investigations of Glass Structures, by Kai Grjotheim *Apr p.* 201

W

Wall Thicknesses of Hollow Glass Vessels, Apparatus for Measuring, by Vivian Bird *Aug p.* 430
Window Glass, Devitrification of *May p.* 276; and Mirror Glass, Price Structure of *May p.* 277

X

X-Ray Methods for Investigations of Glass Structures, by Kai Grjotheim *Apr p.* 201

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